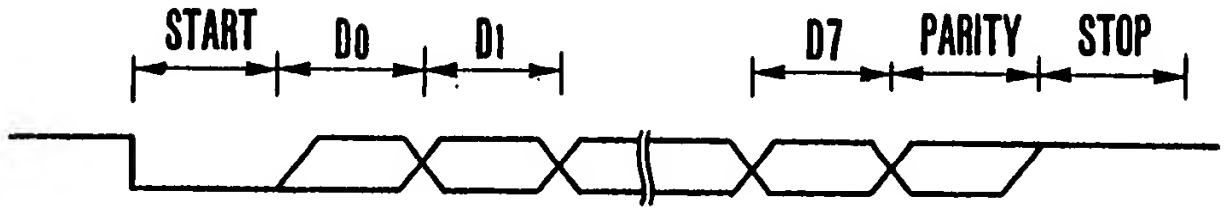

FIG.42

FIG.43(a)

FIG.43(b)

FIG.43(c)

FIG.43(d)

FIG.43(e)

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(54) Dual anode flat panel electrophoretic display apparatus.

(57) An electrophoretic display has a grid cathode matrix arrangement consisting of a first plurality of parallel conductive lines insulated from a second plurality of parallel conductive lines transverse to said first plurality. Located with respect to the grid and cathode lines are first and second anode structures. The first anode is remote from the second with the second anode overlying the gird lines of the display and insulated therefrom. The second anode is biased to implement typical HOLD and ERASE modes independent of the first anode.

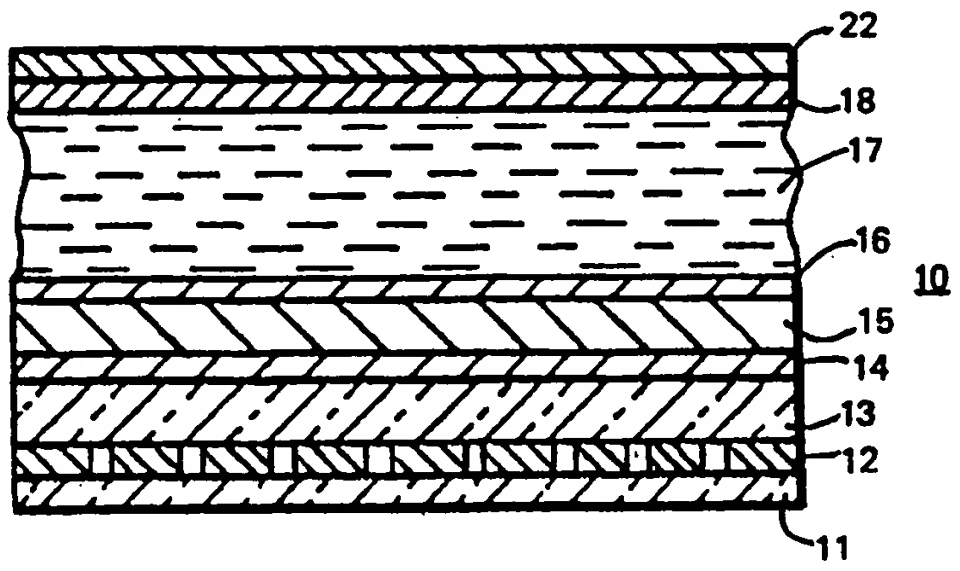

FIG. 1

EP 0 396 247 A2

DUAL ANODE FLAT PANEL ELECTROPHORETIC DISPLAY APPARATUS

Background of the Invention

This invention relates to an electrophoretic display apparatus in general and more particularly to an electrophoretic display apparatus having a dual anode structure.

The electrophoretic display (EPID) is well known and there exists many patents and articles in the prior art which describe the construction, structure as well as describing the operation of such displays. The following patents are illustrative of prior art devices and approaches. These patents issued to Frank J. Disanto and Denis A. Krusos, the inventors herein, and are assigned to Copytele, Inc., the assignee herein.

See for example, U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS.

This patent describes a typical electrophoretic display apparatus utilizing an XY matrix consisting of grid and cathode lines which are insulated one from the other and which are associated with an anode electrode and having the space between the grid and cathode lines and the anode electrode filled with an electrophoretic dispersion. The patent describes techniques for making such displays as well as suitable dispersions for use with such displays.

U.S. 4,732,830 issued on March 22, 1988 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS This patent describes methods for making electrophoretic displays as well as describing display construction and operation.

U.S. 4,742,345 entitled ELECTROPHORETIC DISPLAY PANEL APPARATUS AND METHODS THEREFOR issued on May 3, 1988. This patent describes improved electrophoretic display panels exhibiting improved alignment and contrast with circuitry for implementing the same as well as methods for providing such a panel.

U.S. 4,746,917 issued on May 24, 1988 entitled METHOD AND APPARATUS FOR OPERATING ELECTROPHORETIC DISPLAYS BETWEEN A DISPLAY AND A NON-DISPLAY MODE. This patent describes various biasing techniques for operating electrophoretic displays to provide writing, erasing as well as operating the display during a display and non-display mode.

U.S. 4,772,820 issued on September 20, 1988 entitled MONOLITHIC FLAT PANEL DISPLAY APPARATUS. This patent describes methods and apparatus for fabricating flat panel displays employing electrophoretic principles to enable such displays to be biased and driven by additional circuitry.

As one will understand, by reviewing the above-noted patents, as well as additional subject matter, an important object of the prior art is to provide an improved display with increased contrast, faster operating time, and more reliable performance. A particularly disturbing problem which occurs in electrophoretic displays results in the appearance of a bright "flash" emanating from the display during the ERASE mode. This "flash" while occurring over a relatively short period is perfectly visible. The "flash" appears disturbing to many individuals who view the display and is caused by the following phenomenon. For proper operation of the electrophoretic display, the amount of pigment in the suspension is considerably greater than the pigment required to give a suitable background when the panel is in a HOLD condition. The term HOLD is known in the art, and essentially the electrophoretic panel is placed in a HOLD condition prior to writing the display. In this manner the HOLD conditionis achieved when the anode is at a high positive voltage, the grid is at a low voltage, and the cathode is at a high voltage.

Typically, the anode would be at a voltage for example of 200 volts with the grid at a lower voltage as for example -12 volts with the cathode at a high voltage which would be +15 volts. With these voltages on the typical prior art electrophoretic display, the display is in the so-called HOLD condition. This HOLD condition is implemented prior to the writing mode during which mode new information is written into the display. The excess pigment during the HOLD condition is at the surface of the anode which is at the highest potential with respect to any other of the electrodes. To ERASE the display, the anode is made negative and all the pigment leaves the anode and is at the surface of the grid and cathode. During ERASE, the anode, for example, would be placed at -200 volts. Hence during the ERASE mode, all the pigment leaves the anode and is now at the surface of the grid and cathode accordingly. The cathode side of the flat display during the ERASE mode is considerably brighter than it is during the HOLD causing a bright "flash" to appear on the display even when the ERASE time is extremely short.

The "flash" occurs between frames and may repeat every 20 to 30 milliseconds caused by the change in brightness between the HOLD and the ERASE mode. It is, of course, desirable to eliminate this bright "flash" so that the display appears more uniform and stable.

It is a further object to increase the speed of

the flat panel display while further reducing the anode voltage required during the WRITE and HOLD cycles.

Summary of the Invention

In an electrophoretic display of the type having a cathode matrix comprising a plurality of parallel lines arranged in a given direction, with a grid matrix insulated from said cathode matrix and comprising a plurality of parallel lines each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid, the improvement therewith of an additional anode electrode comprising a plurality of parallel lines each associated with and insulated from a respective grid line with said additional anode operative when biased to control the path of said pigment particles to and from said grid and cathode matrix and to allow excess pigment to remain at said conventional anode electrode.

Brief Description of the Figures

FIG.1 is a cross sectional view of an electrophoretic display according to this invention.

FIG. 2 is a cross sectional view of the display of FIG. 1.

FIG. 3 is a front plan view of a typical grid line and also a configuration of a typical local anode line.

Detailed Description of the Figures

Referring to Fig. 1, there is shown a cross sectional view of an electrophoretic display 10 constructed according to the teachings of this invention.

As one can see from FIG. 1, the display 10 basically appears as prior art displays with the exception that there is an additional electrode 16 which will be designated as a local anode as compared to the remote anode 18. The remote anode 18 is the conventional anode associated with the prior art electrophoretic displays. As one will understand, the electrophoretic display as described in many of the prior art patents as above indicated has a viewing area which includes a bottom glass sheet 11. Disposed upon sheet 11 are a plurality of cathode lines 12. These cathode lines 12 are directed in the horizontal or vertical direction and are essentially parallel to one another to form a matrix or grid of lines. Separated from the cathode lines by means of a photoresist or insulator 13 is a plurality of grid lines 14. The grid lines are disposed transverse to the cathode lines and intersect each cathode line to provide an XY matrix arrangement where by a typical pixel area is accessed by addressing a grid and cathode line and thereby providing a desired potential at the intersection between the two lines. This potential causes the migration of electrophoretic particles which are suspended in the electrophoretic suspension and which particles migrate from the grid and cathode structure to the anode 18. The anode 18 is a very thin layer of metal deposited upon a planar glass member 22 according to prior art teachings.

Referring to FIG. 2, there is shown a side cross sectional view of the electrophoretic display. The cathode lines 12 which are thin layers of ITO are deposited upon the glass substrate 11 with the grid lines 14 being perpendicular thereto and insulated from the cathode line by means of insulator layer 13. The thickness of the insulator areas as 13 and 15 is approximately 3 microns with the distance from the top of insulator 15 to the remote anode electrode 18 being about 7 mils. As seen more clearly in FIG. 2, each grid line 14 is separated from a local anode line 16 by means of an insulator layer 15.

In this manner the local anode 16 is of the same exact configuration as the grid structure 14. The anode 16 is separated from the grid by the insulating layer 15 and is configured the same as the grid structure. Thus, there are as many anode segments as there are grid segments. Each segment of the anode can have the same exact configuration as the grid. For example, U.S. 4,742,345 describes a grid structure fabricated with respect to the cathode structure in the configuration depicted in FIG. 3. As one can see from FIG. 3, each of the grids is fabricated by utilizing deposited metal on an insulator whereby a top conductive area or contact area 30 is provided which conductive area 30 is above a bottom conductive area 31. Disposed between areas 30 and 31 are a series of tines 32 which are grid conductors.

As one can understand, the parallel conductor members 32 as connected in parallel by the contact pair 30 and 31 provide a plurality of intersecting points for each of the grid structures with respect to the cathode line. The advantage of such an arrangement has been fully explained and described in U.S. 4,742,345. If the grid structure of FIG. 3 is employed then the anode structure 16 will follow the grid structure. In this manner it is seen that the local anode 16 may consist of a plurality of

parallel lines each of which is associated with a grid line with each of the parallel lines being dimensioned and congruent with each of the associated grid lines.

One can, of course, connect all the anode lines together at both contact areas 30 and 31 or one can drive each of the anode lines separately or in groups. As will be explained if the anode lines are separately driven or driven in regard to associated groups then one can achieve selective erasing as well as selective writing with this display. For purposes of explaining the operation of the unique flat panel display depicted in FIG. 1 and FIG. 2, first assume that all the anode segments 16 or anode lines are connected in parallel. In this manner the operation is as follows.

To obtain a full ERASE from the remote anode 18, one applies a negative high voltage to the remote anode 18 which for example is -200 volts. One then applies a negative low voltage to the local anode 16 or to each of the local anode lines 16 of -15 volts. In this manner one then keeps the grid at a low voltage as for example -12 volts and keeps the cathode lines at a high voltage which is +15 volts. These biasing levels operate to ERASE the display and cause all the pigment to be transported to the surface of the grid and cathode. During a first HOLD mode, the excess pigment is brought to the remote anode 18. In this first HOLD mode the anode 18 which is the remote anode is held at a positive high voltage which may be for example +200 volts. The local anode 16 is placed at a positive low voltage which is +15 volts and the grid and cathode are held at -12 volts and +15 volts respectively as indicated above for the full ERASE mode. This first HOLD mode operates to bring the excess pigment to the remote anode as described above. As one can ascertain, the brightness of the display between HOLD and ERASE differs as described above.

In a second HOLD mode anode voltage 18 is biased at a positive low voltage which is +15 volts while the anode 16 is placed at the same positive low voltage which is +15 volts. The grid and cathode again are at the same polarities as the full ERASE mode or as in the first HOLD mode as indicated above. In this second HOLD, as one can ascertain, since anodes 18 and 16 are at the same potential, all the excess pigment is held mainly at anode 18 with very little pigment being held at anode 16.

In order to implement a writing operation, this is done as was accomplished in the prior art flat panels. For a WRITE the anode 18 is held at a low voltage as +15 volts. Anode 16 is also held at the same positive low voltage. The grid and cathodes will enable a WRITE when a grid line is at a high condition with respect to a cathode line which is at a low condition. When both the grid and cathodes are both high, there will be no writing. In a similar manner if grid and cathodes are both low, there is no writing; or if the grid is low and cathode is high, there is no writing.

Hence, as one can understand, the only time a pixel is written into is when the respective grid line is high with the cathode line being low and hence causing particle migration at the intersection between that grid and that cathode to thereby perform a writing operation. A selective ERASE mode from the anode structure 16 is as follows.

In this selective ERASE mode, the anode 18 is held at a low positive voltage +15. The anode lines 16 are held at approximately ground potential or zero. In order to implement an ERASE of a given pixel, one requires the grid and cathode line at an intersection both to be high. The high condition on both grid and cathode lines will produce an ERASE signal at that pixel. There will be no ERASE when the grid is low with respect to the cathode being high or when the grid is low and the cathode is low or when the grid is high and the cathode is low. The only time an ERASE will occur is when both the grid and cathode are high. It is obvious when considering the mode designated as ERASE that the flat panel can be completely ERASED by making all the grids and cathodes high and the voltage at the anode 16 or each anode line approximately zero. In a similar manner one can selectively ERASE by making the anode voltage approximately zero and scanning the cathodes with a high and for each cathode made high selecting which grids are also to be high.

In this manner, one can provide selective erasing at any grid and cathode intersection. In a similar manner one can ERASE on a line by line basis. This will occur by scanning the anode lines and placing each anode line at ground during a scan interval and simultaneous therewith providing the associated grid lines with a high and the associated cathode line with a high. In this manner as one can see, one can ERASE a single line at a time or ERASE any particular line in the display at any instant of time.

The selective ERASE may be performed by scanning the entire panel or by pointing and scanning only certain character lines. The selective ERASE permits correction of a character or characters, blinking of a character or characters and allows access to any pixel in the entire display. By utilizing the above-described local anode 16, one can selectively ERASE any point or pixel in the display as well as selectively ERASE line by line.

Furthermore, since the excess pigment is caused to remain at the remote anode then one does not in any manner see the "flash" when erasure occurs from the local anodes 16 as compared to

the prior art erasing mode which occurred at the remote anode 18. The panel is fabricated utilizing the same techniques as evidenced by the prior art. Thus the display shown is operated by first providing the HOLD function from the remote anode 18 and thereafter ERASING and HOLDING from the local anode 16.

As one can ascertain from referring to U.S. 4,742,345, the cathode configuration is deposited upon the glass sheet 11 employing ITO and is constructed in the same manner as implemented in previous flat panels. An insulator which is a photoresist is applied to the cathode structure and the insulator is then coated with a thin layer of metal (metal 1). This metal layer may be chrome or some other material.

An insulator is applied to the metal layer and a thin layer of another metal (metal 2) is then applied to the insulator. This other metal may be nickel, aluminum, or some other metal. A layer of photoresist is applied to the second metal layer and is patterned in the usual way utilizing the grid mask. The metal layer 2 is then etched using a suitable etching solution depending upon the properties of the metal. The insulating layer between the first metal layer and the second metal layer is plasma etched. Using a suitable etching solution, the metal layer 1 is etched. It is indicated that the first metal layer and the second metal layer are selected such that the etching solution for the first metal layer does not effect the second metal layer. There are many solutions which will etch certain materials while not etching others.

The insulating layer between metal layer 1 and the cathode is next plasma etched. The metal in the chip area is etched leaving only the insulator between metal layer 1 and metal layer 2 and the insulator between metal layer 1 and the cathode. Prior to assembly a thin film of S_iO_2 is deposited on the entire surface except for the cathode and grid chip areas. The display parts comprising the structure indicated in FIG. 2 are assembled using appropriate spacers. The insulator on the surface of the first metal layer is removed and the flat panel is ready to receive the chips. The prior art panels, including the chips of the panel are further described in conjunction with the prior art patents.

The difference between the structure here and those of the prior art is the inclusion of an additional and different anode structure which is a series of lines congruent with and insulated from the grid lines. The second anode line structure can have all lines connected together at both top and bottom as described above or each of the anode lines can be separately addressed. The anode is for example fabricated from aluminum with the grid being fabricated from chrome. In this manner one can utilize different etchants to form the local anode structure 16 as compared to the typical grid structure 14 and hence obtain all the benefits of the above-noted structure.

Claims

1. In an electrophoretic display of the type having a cathode matrix comprising a plurality of parallel lines arranged in a given direction, with a grid matrix insulated from said cathode matrix and comprising a plurality of parallel lines each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid, the improvement therewith of:
an additional anode electrode comprising a plurality of parallel lines each associated with and insulated from a respective grid line with said additional anode operative when biased to control the path of said pigment particles to and from said grid and cathode matrix and to allow excess pigment to remain at said conventional anode electrode.

2. The electrophoretic display according to Claim 1, wherein said additional anode lines are of the same configuration as said grid lines.

3. The electrophoretic display according to Claim 2, wherein said grid lines are fabricated from chrome with said additional anode lines fabricated from aluminum.

4. The electrophoretic display apparatus according to Claim 1, wherein said additional anode lines are connected together.

5. The electrophoretic display according to Claim 1, wherein groups of said anode lines are connected together to enable selective ERASING of said display.

6. The electrophoretic display according to Claim 1, wherein said additional anode lines as insulated from said grid lines are separated therefrom by between 2-5 microns.

7. The electrophoretic display according to Claim 6, wherein each one of said grid lines is of a tine-like configuration comprising a plurality of parallel lines coupled together at a top contact and a bottom contact.

8. An electrophoretic display panel apparatus, comprising:
a planar member,
a first plurality of conductive lines deposited in a first direction of said planar member, each of said first plurality of conductive lines being disposed in parallel on said planar member,
a second plurality of conductive lines disposed in a second direction on said planar member with said

second direction being transverse to said first direction, each of said second plurality of conductive lines spatially crossing each of said first plurality of conductive lines to form a plurality of intersections therebetween, a third plurality of conductive lines disposed in said second direction of said planar member with each of said third plurality of lines parallel to each of said second plurality of lines and means for insulating said first plurality of conductive lines from said second plurality of conductive lines and from said third plurality of conductive lines and,

means overlying said planar member and said first, second and third plurality of conductive lines for establishing a fluid-tight panel, with said means overlying creating a space above said planar member for maintaining an electrophoretic dispersion with said means including a thin conductive film located thereon for receiving electrophoretic particles and,

means for biasing said first, second and third plurality of conductive lines with respect to said conductive film to control the transportation of said particles within said display.

9. The electrophoretic display according to Claim 8, wherein said second plurality of lines are fabricated from chrome with said third plurality of lines fabricated from aluminum.

10. The electrophoretic display according to Claim 9, wherein said planar member is glass with said first plurality of lines being fabricated from ITO.

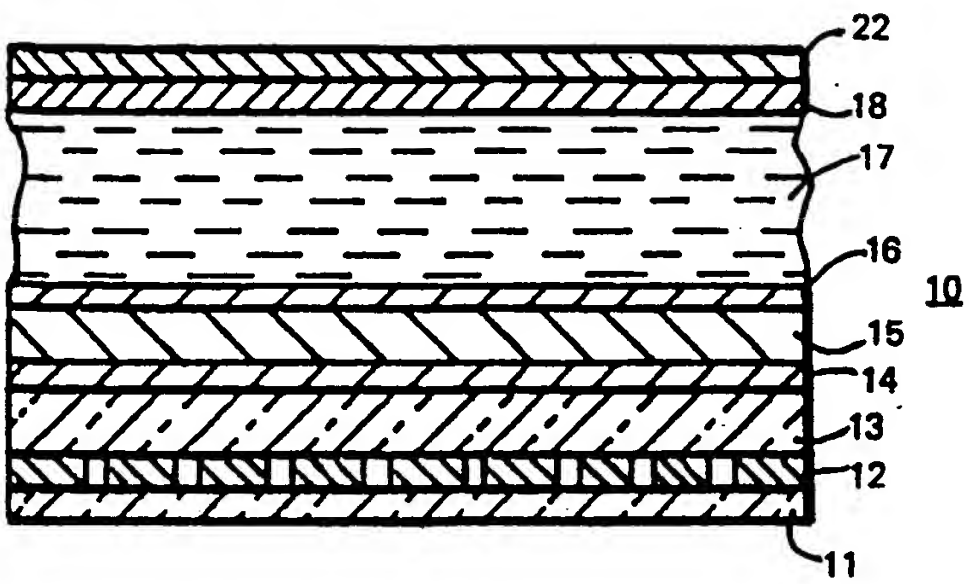

FIG. 1

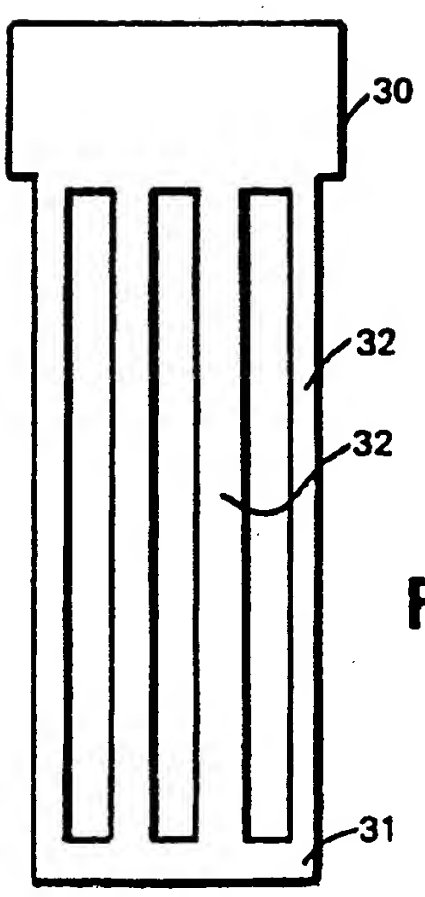

FIG. 3

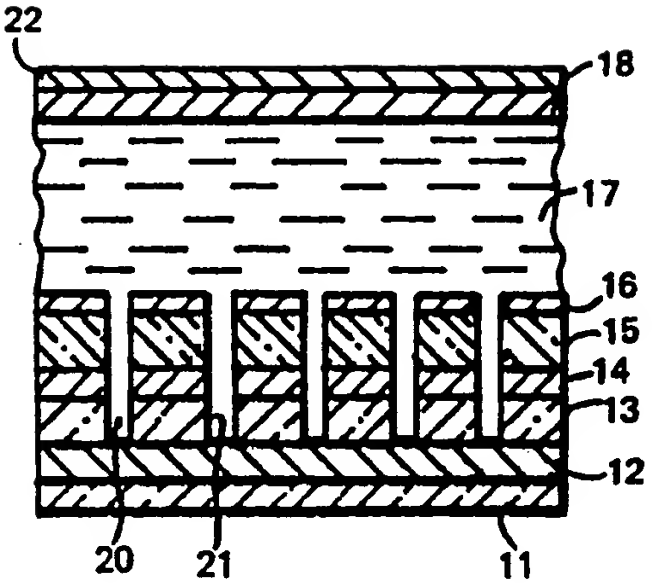

FIG. 2

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(54) Dual anode flat panel electrophoretic display apparatus.

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US-A- 4 742 345
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(74) Representative : **Wombwell, Francis et al**
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EP 0 396 247 B1

Description

Background of the Invention

This invention relates to an electrophoretic display apparatus in general and more particularly to an electrophoretic display apparatus having a dual anode structure.

The electrophoretic display (EPID) is well known and there exists many patents and articles in the prior art which describe the construction, structure as well as describing the operation of such displays. The following patents are illustrative of prior art devices and approaches. These patents issued to Frank J. Disanto and Denis A. Krusos, the inventors herein, and are assigned to Copytele, Inc., the assignee herein.

See for example, U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS.

This patent describes a typical electrophoretic display apparatus utilizing an XY matrix consisting of grid and cathode lines which are insulated one from the other and which are associated with an anode electrode and having the space between the grid and cathode lines and the anode electrode filled with an electrophoretic dispersion. The patent describes techniques for making such displays as well as suitable dispersions for use with such displays.

U.S. 4,732,830 issued on March 22, 1988 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS This patent describes methods for making electrophoretic displays as well as describing display construction and operation.

U.S. 4,742,345 entitled ELECTROPHORETIC DISPLAY PANEL APPARATUS AND METHODS THEREFOR issued on May 3, 1988. This patent describes improved electrophoretic display panels exhibiting improved alignment and contrast with circuitry for implementing the same as well as methods for providing such a panel.

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U.S. 4,772,820 issued on September 20, 1988 entitled MONOLITHIC FLAT PANEL DISPLAY APPARATUS. This patent describes methods and apparatus for fabricating flat panel displays employing electrophoretic principles to enable such displays to be biased and driven by additional circuitry.

As one will understand, by reviewing the above-noted patents, as well as additional subject matter, an important object of the prior art is to provide an improved display with increased contrast, faster operating time, and more reliable performance. A particularly disturbing problem which occurs in electrophoretic displays results in the appearance of a bright "flash" emanating from the display during the ERASE mode. This "flash" while occurring over a relatively short period is perfectly visible. The "flash" appears disturbing to many individuals who view the display and is caused by the following phenomenon. For proper operation of the electrophoretic display, the amount of pigment in the suspension is considerably greater than the pigment required to give a suitable background when the panel is in a HOLD condition. The term HOLD is known in the art, and essentially the electrophoretic panel is placed in a HOLD condition prior to writing the display. In this manner the HOLD condition is achieved when the anode is at a high positive voltage, the grid is at a low voltage, and the cathode is at a high voltage.

Typically, the anode would be at a voltage for example of 200 volts with the grid at a lower voltage as for example -12 volts with the cathode at a high voltage which would be +15 volts. With these voltages on the typical prior art electrophoretic display, the display is in the so-called HOLD condition. This HOLD condition is implemented prior to the writing mode during which mode new information is written into the display. The excess pigment during the HOLD condition is at the surface of the anode which is at the highest potential with respect to any other of the electrodes. To ERASE the display, the anode is made negative and all the pigment leaves the anode and is at the surface of the grid and cathode. During ERASE, the anode, for example, would be placed at -200 volts. Hence during the ERASE mode, all the pigment leaves the anode and is now at the surface of the grid and cathode accordingly. The cathode side of the flat display during the ERASE mode is considerably brighter than it is during the HOLD causing a bright "flash" to appear on the display even when the ERASE time is extremely short.

The "flash" occurs between frames and may repeat every 20 to 30 milliseconds caused by the change in brightness between the HOLD and the ERASE mode. It is, of course, desirable to eliminate this bright "flash" so that the display appears more uniform and stable.

It is a further object to increase the speed of the flat panel display while further reducing the anode voltage required during the WRITE and HOLD cycles.

Summary of the Invention

This object is achieved by the device as defined in claim 1.

Brief Description of the Figures

FIG. 1 is a cross sectional view of an electrophor-

etic display according to this invention.

FIG. 2 is a cross sectional view of the display of FIG. 1.

FIG. 3 is a front plan view of a typical grid line and also a configuration of a typical local anode line.

Detailed Description of the Figures

Referring to Fig. 1, there is shown a cross sectional view of an electrophoretic display 10 constructed according to the teachings of this invention.

As one can see from FIG. 1, the display 10 basically appears as prior art displays with the exception that there is an additional electrode 16 which will be designated as a local anode as compared to the remote anode 18. The remote anode 18 is the conventional anode associated with the prior art electrophoretic displays. As one will understand, the electrophoretic display as described in many of the prior art patents as above indicated has a viewing area which includes a bottom glass sheet 11. Disposed upon sheet 11 are a plurality of cathode lines 12. These cathode lines 12 are directed in the horizontal or vertical direction and are essentially parallel to one another to form a matrix or grid of lines. Separated from the cathode lines by means of a photoresist or insulator 13 is a plurality of grid lines 14. The grid lines are disposed transverse to the cathode lines and intersect each cathode line to provide an XY matrix arrangement where by a typical pixel area is accessed by addressing a grid and cathode line and thereby providing a desired potential at the intersection between the two lines. This potential causes the migration of electrophoretic particles which are suspended in the electrophoretic suspension and which particles migrate from the grid and cathode structure to the anode 18. The anode 18 is a very thin layer of metal deposited upon a planar glass member 22 according to prior art teachings.

Referring to FIG. 2, there is shown a side cross sectional view of the electrophoretic display. The cathode lines 12 which are thin layers of ITO are deposited upon the glass substrate 11 with the grid lines 14 being perpendicular thereto and insulated from the cathode line by means of insulator layer 13. The thickness of the insulator areas as 13 and 15 is approximately 3 microns with the distance from the top of insulator 15 to the remote anode electrode 18 being about 0.178 mm (7 mils). As seen more clearly in FIG. 2, each grid line 14 is separated from a local anode line 16 by means of an insulator layer 15.

In this manner the local anode 16 is of the same exact configuration as the grid structure 14. The anode 16 is separated from the grid by the insulating layer 15 and is configured the same as the grid structure. Thus, there are as many anode segments as there are grid segments. Each segment of the anode can have the same exact configuration as the grid. For example, U.S. 4,742,345 describes a grid structure fabricated with respect to the cathode structure in the configuration depicted in FIG. 3. As one can see from FIG. 3, each of the grids is fabricated by utilizing deposited metal on an insulator whereby a top conductive area or contact area 30 is provided which conductive area 30 is above a bottom conductive area 31. Disposed between areas 30 and 31 are a series of tines 32 which are grid conductors.

As one can understand, the parallel conductor members 32 as connected in parallel by the contact pair 30 and 31 provide a plurality of intersecting points for each of the grid structures with respect to the cathode line. The advantage of such an arrangement has been fully explained and described in U.S. 4,742,345. If the grid structure of FIG. 3 is employed then the anode structure 16 will follow the grid structure. In this manner it is seen that the local anode 16 may consist of a plurality of parallel lines each of which is associated with a grid line with each of the parallel lines being dimensioned and congruent with each of the associated grid lines.

One can, of course, connect all the anode lines together at both contact areas 30 and 31 or one can drive each of the anode lines separately or in groups. As will be explained if the anode lines are separately driven or driven in regard to associated groups then one can achieve selective erasing as well as selective writing with this display. For purposes of explaining the operation of the unique flat panel display depicted in FIG. 1 and FIG. 2, first assume that all the anode segments 16 or anode lines are connected in parallel. In this manner the operation is as follows.

To obtain a full ERASE from the remote anode 18, one applies a negative high voltage to the remote anode 18 which for example is -200 volts. One then applies a negative low voltage to the local anode 16 or to each of the local anode lines 16 of -15 volts. In this manner one then keeps the grid at a low voltage as for example -12 volts and keeps the cathode lines at a high voltage which is +15 volts. These biasing levels operate to ERASE the display and cause all the pigment to be transported to the surface of the grid and cathode. During a first HOLD mode, the excess pigment is brought to the remote anode 18. In this first HOLD mode the anode 18 which is the remote anode is held at a positive high voltage which may be for example +200 volts. The local anode 16 is placed at a positive low voltage which is +15 volts and the grid and cathode are held at -12 volts and +15 volts respectively as indicated above for the full ERASE mode. This first HOLD mode operates to bring the excess pigment to the remote anode as described above. As one can ascertain, the brightness of the display between HOLD and ERASE differs as described above.

In a second HOLD mode anode voltage 18 is biased at a positive low voltage which is +15 volts

while the anode 16 is placed at the same positive low voltage which is +15 volts. The grid and cathode again are at the same polarities as the full ERASE mode or as in the first HOLD mode as indicated above. In this second HOLD, as one can ascertain, since anodes 18 and 16 are at the same potential, all the excess pigment is held mainly at anode 18 with very little pigment being held at anode 16.

In order to implement a writing operation, this is done as was accomplished in the prior art flat panels. For a WRITE the anode 18 is held at a low voltage as +15 volts. Anode 16 is also held at the same positive low voltage. The grid and cathodes will enable a WRITE when a grid line is at a high condition with respect to a cathode line which is at a low condition. When both the grid and cathodes are both high, there will be no writing. In a similar manner if grid and cathodes are both low, there is no writing; or if the grid is low and cathode is high, there is no writing.

Hence, as one can understand, the only time a pixel is written into is when the respective grid line is high with the cathode line being low and hence causing particle migration at the intersection between that grid and that cathode to thereby perform a writing operation. A selective ERASE mode from the anode structure 16 is as follows.

In this selective ERASE mode, the anode 18 is held at a low positive voltage +15. The anode lines 16 are held at approximately ground potential or zero. In order to implement an ERASE of a given pixel, one requires the grid and cathode line at an intersection both to be high. The high condition on both grid and cathode lines will produce an ERASE signal at that pixel. There will be no ERASE when the grid is low with respect to the cathode being high or when the grid is low and the cathode is low or when the grid is high and the cathode is low. The only time an ERASE will occur is when both the grid and cathode are high. It is obvious when considering the mode designated as ERASE that the flat panel can be completely ERASED by making all the grids and cathodes high and the voltage at the anode 16 or each anode line approximately zero. In a similar manner one can selectively ERASE by making the anode voltage approximately zero and scanning the cathodes with a high and for each cathode made high selecting which grids are also to be high.

In this manner, one can provide selective erasing at any grid and cathode intersection. In a similar manner one can ERASE on a line by line basis. This will occur by scanning the anode lines and placing each anode line at ground during a scan interval and simultaneous therewith providing the associated grid lines with a high and the associated cathode line with a high. In this manner as one can see, one can ERASE a single line at a time or ERASE any particular line in the display at any instant of time.

The selective ERASE may be performed by scanning the entire panel or by pointing and scanning only certain character lines. The selective ERASE permits correction of a character or characters, blinking of a character or characters and allows access to any pixel in the entire display. By utilizing the above-described local anode 16, one can selectively ERASE any point or pixel in the display as well as selectively ERASE line by line.

Furthermore, since the excess pigment is caused to remain at the remote anode then one does not in any manner see the "flash" when erasure occurs from the local anodes 16 as compared to the prior art erasing mode which occurred at the remote anode 18. The panel is fabricated utilizing the same techniques as evidenced by the prior art. Thus the display shown is operated by first providing the HOLD function from the remote anode 18 and thereafter ERASING and HOLDING from the local anode 16.

As one can ascertain from referring to U.S. 4,742,345, the cathode configuration is deposited upon the glass sheet 11 employing ITO and is constructed in the same manner as implemented in previous flat panels. An insulator which is a photoresist is applied to the cathode structure and the insulator is then coated with a thin layer of metal (metal 1). This metal layer may be chrome or some other material.

An insulator is applied to the metal layer and a thin layer of another metal (metal 2) is then applied to the insulator. This other metal may be nickel, aluminum, or some other metal. A layer of photoresist is applied to the second metal layer and is patterned in the usual way utilizing the grid mask. The metal layer 2 is then etched using a suitable etching solution depending upon the properties of the metal. The insulating layer between the first metal layer and the second metal layer is plasma etched. Using a suitable etching solution, the metal layer 1 is etched. It is indicated that the first metal layer and the second metal layer are selected such that the etching solution for the first metal layer does not effect the second metal layer. There are many solutions which will etch certain materials while not etching others.

The insulating layer between metal layer 1 and the cathode is next plasma etched. The metal in the chip area is etched leaving only the insulator between metal layer 1 and metal layer 2 and the insulator between metal layer 1 and the cathode. Prior to assembly a thin film of S_iO_2 is deposited on the entire surface except for the cathode and grid chip areas. The display parts comprising the structure indicated in FIG. 2 are assembled using appropriate spacers. The insulator on the surface of the first metal layer is removed and the flat panel is ready to receive the chips. The prior art panels, including the chips of the panel are further described in conjunction with the prior art patents.

The difference between the structure here and those of the prior art is the inclusion of an additional

and different anode structure which is a series of lines congruent with and insulated from the grid lines. The second anode line structure can have all lines connected together at both top and bottom as described above or each of the anode lines can be separately addressed. The anode is for example fabricated from aluminum with the grid being fabricated from chrome. In this manner one can utilize different etchants to form the local anode structure 16 as compared to the typical grid structure 14 and hence obtain all the benefits of the above-noted structure.

Claims

1. An electrophoretic display (10) of the type having a cathode structure comprising a plurality of electrically conductive lines (12) arranged in a given direction, with a grid structure insulated from said cathode structure and comprising a plurality of electrically conductive grid lines (14) each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode (18) separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion (17) including pigment particles suspended in a fluid, characterized by:

   an additional anode electrode (16) comprising a plurality of electrically conductive parallel lines each associated with and insulated from a respective grid line (14) of said grid structure with said additional anode (16) operative when biased to control the path of said pigment particles to and from said grid and cathode matrix (X-Y) and to allow excess pigment to remain at said conventional anode electrode (18).

2. The electrophoretic display according to Claim 1, wherein said additional anode lines (16) are of the same configuration as said grid lines (14).

3. The electrophoretic display according to Claim 2, wherein said grid lines (14) are fabricated from chrome with said additional anode lines (16) fabricated from aluminum.

4. The electrophoretic display apparatus according to Claim 1, wherein said additional anode lines (16) are connected together.

5. The electrophoretic display according to Claim 1, wherein groups of said anode lines (16) are connected together to enable selective ERASING of said display.

6. The electrophoretic display according to Claim 1, wherein said additional anode lines (16) as insulated from said grid lines (14) are separated therefrom by between 2-5 micrometer.

7. The electrophoretic display according to Claim 6, wherein each one of said grid lines (14) is of a tine-like configuration comprising a plurality of parallel lines (32) coupled together at a top contact (30) and a bottom contact (31).

8. The electrophoretic display according to Claim 1, wherein said cathode lines (12) are fabricated from ITO.

9. The electrophoretic display according to Claim 8, wherein said cathode lines are deposited on a planar member of glass (11).

Patentansprüche

1. Elektrophoretische Anzeigevorrichtung (10) des Typs mit einer Kathodenstruktur, die eine Vielzahl von elektrisch leitenden, in einer gegebenen Richtung angeordneten Leitungen (12) aufweist, mit einer Gitterstruktur, die von der Kathodenstruktur isoliert ist und eine Vielzahl von elektrisch leitenden Gitterleitungen (14) aufweist, die jeweils senkrecht zu den Kathodenleitungen liegen, um eine X-Y-Adressiermatrix mit einer herkömmlichen, von der X-Y-Matrix getrennten Anodenelektrode (18) zu bilden, wobei der Raum zwischen der Anodenelektrode und der X-Y-Matrix eine elektrophoretische Dispersion (17) aufnimmt, die in einem Fluid suspendierte Pigmentteilchen umfaßt, gekennzeichnet durch:

   eine zusätzliche Anodenelektrode (16), die eine Vielzahl von elektrisch leitenden, parallelen Leitungen aufweist, die jeweils einer entsprechenden Gitterleitung (14) der Gitterstruktur zugeordnet und davon isoliert sind, wobei die zusätzliche Anode (16) bei Vorspannung wirksam ist, um den Pfad der Pigmentteilchen zu und von der Gitterund Kathodenmatrix (X-Y) zu steuern und zuzulassen, daß überschüssige Pigmente an der herkömmlichen Anodenelektrode (18) bleiben.

2. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die zusätzlichen Anodenleitungen (16) die gleiche Ausgestaltung wie die Gitterleitungen (14) aufweisen.

3. Elektrophoretische Anzeigevorrichtung nach Anspruch 2, bei welcher die Gitterleitungen (14) aus Chrom hergestellt sind, wobei die zusätzlichen Anodenleitungen (16) aus Aluminium hergestellt sind.

4. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die zusätzlichen Anodenleitungen (16) miteinander verbunden sind.

5. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher Gruppen der Anodenleitungen (16) miteinander verbunden sind, um ein selektives LÖSCHEN der Anzeigevorrichtung zu ermöglichen.

6. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die zusätzlichen, von den Gitterleitungen (14) isolierten Anodenleitungen (16) davon zwischen 2 - 5 Mikrometer getrennt sind.

7. Elektrophoretische Anzeigevorrichtung nach Anspruch 6, bei welcher jede der Gitterleitungen (14) von zinkenartiger Ausgestaltung ist, die eine Vielzahl von an einem oberen Kontakt (30) und einem Bodenkontakt (31) zusammengekoppelten, parallelen Leitungen aufweist.

8. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die Kathodenleitungen (12) aus ITO hergestellt sind.

9. Elektrophoretische Anzeigevorrichtung nach Anspruch 8, bei welcher die Kathodenleitungen auf einem planaren Element (11) aus Glas aufgebracht sind.

Revendications

1. Dispositif d'affichage électrophorétique (10) du type pourvu d'une structure de cathode comprenant une pluralité de lignes électriquement conductrices (12) disposées dans un sens déterminé, avec une structure de grille isolée par rapport à ladite structure de cathode et comprenant une pluralité de lignes de grille électriquement conductrices (14), chacune étant perpendiculaire auxdites lignes de cathode pour constituer une matrice d'adressage X-Y avec une électrode anode classique (18) séparée par rapport à ladite matrice X-Y, l'espace entre ladite électrode anode et ladite matrice X-Y recevant une solution électrophorétique (17) incluant des particules de pigment en suspension dans un fluide, caractérisé par :

une électrode anode supplémentaire (16) comprenant une pluralité de lignes parallèles électriquement conductrices, chacune étant associée à une ligne de grille respective (14) de ladite structure de grille, et isolée par rapport à celle-ci, ladite anode supplémentaire (16) étant active lorsqu'elle est polarisée de façon à commander le champ desdites particules de pigment vers ladite matrice de grille et de cathode (X-Y), et depuis celle-ci, et pour permettre à l'excès de pigment de rester sur ladite électrode anode classique (18).

2. Dispositif d'affichage électrophorétique selon la revendication 1, dans lequel les lignes d'anode supplémentaires (16) sont d'une conformation identique à celles desdites lignes de grille (14).

3. Dispositif d'affichage électrophorétique selon la revendication 2, dans lequel lesdites lignes de grille (14) sont fabriquées à partir de chrome alors que lesdites lignes d'anodes supplémentaires (16) sont fabriquées à partir d'aluminium.

4. Dispositif d'affichage électrophorétique selon la revendication 1, dans lequel lesdites lignes d'anode supplémentaires (16) sont reliées ensemble.

5. Dispositif d'affichage électrophorétique selon la revendication 1, dans lequel des groupes desdites lignes d'anode (16) sont reliées ensemble pour permettre un EFFACEMENT sélectif dudit dispositif d'affichage.

6. Dispositif d'affichage électrophorétique selon la revendication 1, dans lequel lesdites lignes d'anode supplémentaires (16), isolées par rapport auxdites lignes de grille (14), sont séparées de celles-ci d'une distance comprise entre 2 et 5 microns.

7. Dispositif d'affichage électrophorétique selon la revendication 6, dans lequel chacune desdites lignes de grille (14) est d'une conformation en forme de pointe comprenant une pluralité de lignes parallèles (32) couplées ensemble sur un contact supérieur (30) et un contact inférieur (31).

8. Dispositif d'affichage électrophorétique selon la revendication 1, dans lequel lesdites lignes de cathode (12) sont fabriquées à partir d'ITO.

9. Dispositif d'affichage électrophorétique selon la revendication 8, dans lequel lesdites lignes de cathode sont déposées sur un élément en verre plan (11).

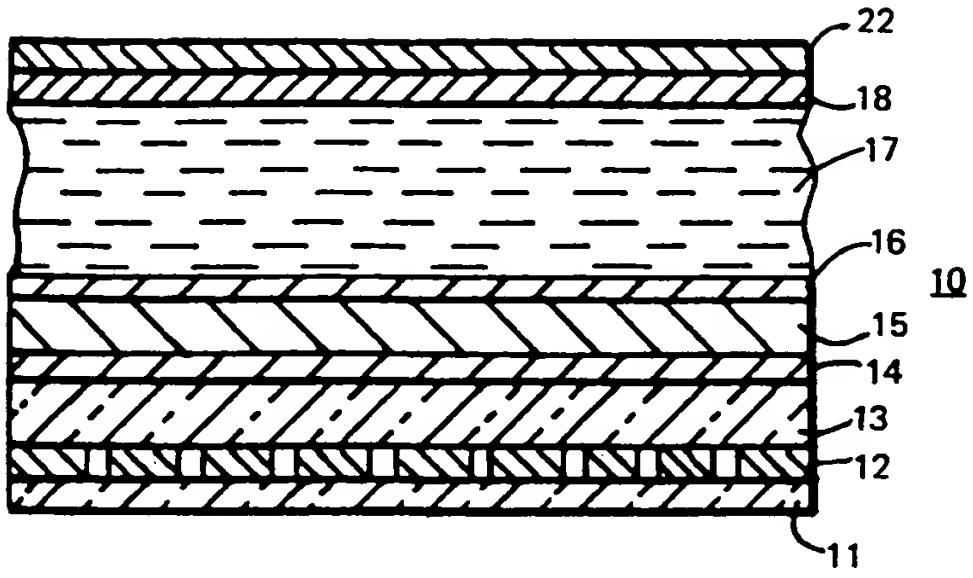

FIG. 1

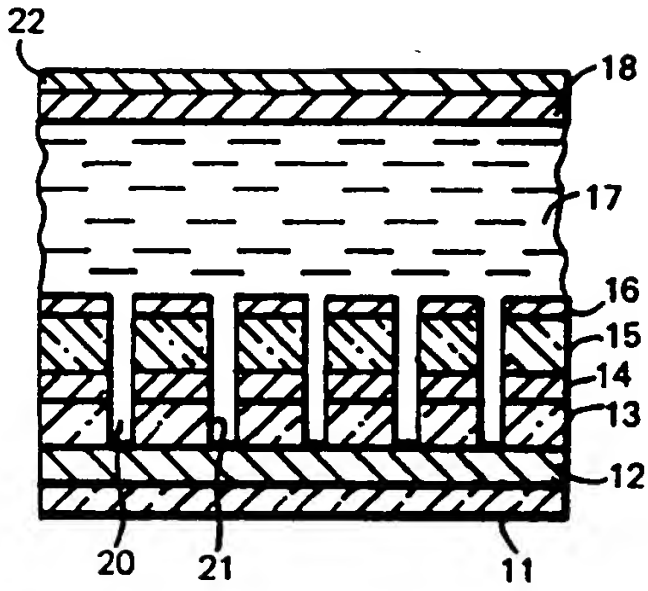

FIG. 2

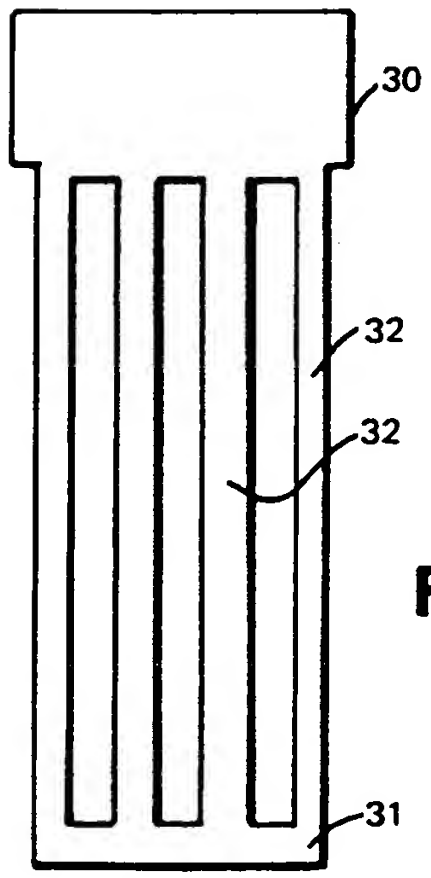

FIG. 3

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(54) **Data/facsimile telephone subset apparatus incorporating electrophoretic display.**

(57) There is disclosed a telephone subset which incorporates a high resolution electrophoretic display on the surface of a subset housing. The telephone subset includes a microprocessor which operates under the control of a mode selector. In this manner the display is employed to generate various keyboard formats and operates in conjunction with a position sensitive overlay to enable a subscriber to place telephone calls in a conventional manner when the keyboard display is implemented on the electrophoretic display. The telephone subset in conjunction with various subset buttons which control the mode selector is capable of operating in different modes. Due to the high resolution and large capacity of the display one can now present pages of stored telephone numbers which essentially enables a user to select any number by means of a movable cursor and by pressing another subset button can immediately dial that number. Other modes provide credit card storage which are accessible and displayed as well as other privacy operative modes which are implemented by means of the high resolution display, microprocessor and associated circuitry.

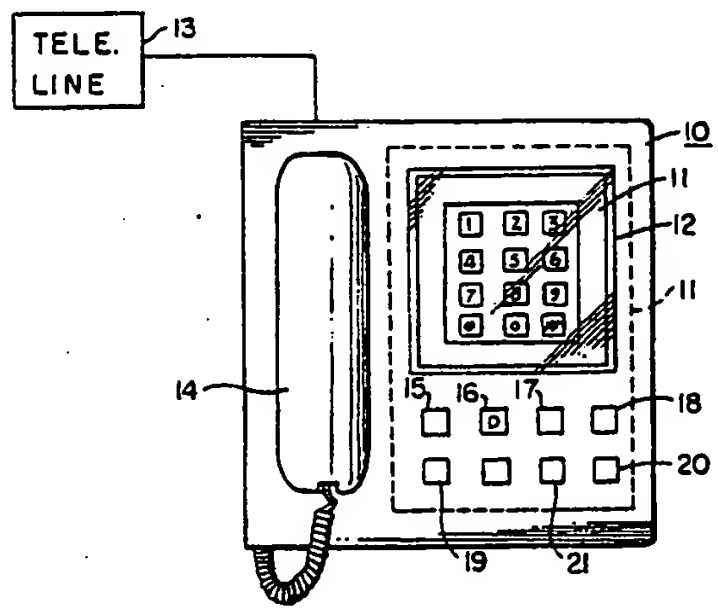

FIG. 1

EP 0 417 362 A1

DATA/FACSIMILE TELEPHONE SUBSET APPARATUS INCORPORATING ELECTROPHORETIC DISPLAYS

BACKGROUND OF THE INVENTION

This invention relates generally to a telephone subset and more particularly to a data/facsimile telephone subset which employs a high resolution electrophoretic display.

In the present technology there are many telephones or subsets which are available, which phones are associated with various display devices. Many telephones incorporate LCD displays which can, for example, display the time of day, the date, as well as the telephone number which is dialed. Certain of these displays will also give an indication of how long the conversation lasts by providing a timing means which is also viewable on the display. Such telephones or subsets, which are available from many sources, are widely employed in present day use and essentially the display normally consists of a line of data such as, for example, the displays can display a telephone number as a single telephone number or may display a date and time of day. There are other telephone subsets which are available at airports, motels and so on and which have a more complete display as, for example, a CRT display or a gas discharge display.

These telephones can be employed for many different purposes and provide a consumer or a caller with visual data allowing him to coact with the telephone subset or with the telephone company through the data displayed. Hence, it is apparent that the prior art is replete with telephone subsets of various sorts which include various displays.

Recently, the assignee herein, namely, Copytele of Huntington Station, has developed and demonstrated a high resolution electrophoretic display which display is extremely thin and has the capability of providing a large number of lines to provide excellent resolution. For an example of such a display, reference is made to U.S. Patent No. 4,655,897 which issued on April 7, 1987 to Frank J. DiSanto and Denis A. Krusos and entitled "Electrophoretic Display Panels and Associated Methods". The patent discloses an electrophoretic display apparatus which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line patterns is filled in with an electrophoretic dispersion containing chargeable pigment particles. When a voltage is impressed between the X and Y lines pigment particles, which are located in wells or depressions between the X and Y pattern, are caused to migrate towards the conductive plate and are deposited upon the conductive plate in accordance with the bias applied to the X and Y line conductors. There is described various electrophoretic dispersions which are suitable for operating with the display, as well as techniques for fabricating the display. In this manner such displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution at very low power.

It is an object of the present invention to provide a unique telephone subset which incorporates, on a major surface thereof, an electrophoretic display as the type described in U.S. Patent No. 4,655,897.

It is a further object to provide an improved data telephone subset which can be employed for various purposes due to the high resolution electrophoretic display associated therewith.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

A telephone subset apparatus for use in providing high quality data displays, comprising a telephone subset including a housing having a telephone handset coupled thereto, a high resolution display panel means mounted on said top surface of said housing and capable of being accessed by an X-Y addressing means to display graphic data in a plurality of lines, microprocessor means coupled to said display panel and operative to cause said panel to provide a graphic presentation of a telephone keyboard arrangement according to said X-Y addressing means, position sensitive means coupled to said panel and operative when accessed to produce a telephone number output signal as dialed by a user employing said graphic keyboard presentation as a guide for selecting said number.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a top plan view of a telephone subset having an electrophoretic display according to this invention.

FIG. 2 is a diagram depicting a particular type of

graphic keyboard format which can be employed in conjunction with the subset of FIG. 1.
FIG. 3 is a schematic diagram depicting another type of graphic keyboard format.
FIG. 4 is a block diagram showing a telephone subset operating in conjunction with a display according to this invention.
FIG. 5 is a diagram depicting another type of display which can be employed with this invention.
FIG. 6 is a detailed block diagram depicting the operation of the subset according to this invention.
FIG. 7 is a system schematic diagram showing the use of the telephone subset in both a data and telephone mode.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 there is shown a telephone subset 10 which includes a handset 14 normally including a transmitter and receiver portion. Essentially, the entire mechanism for the subset, including the transmitter and receiving portion, as well as the various circuitry to activate ringing and so on, are well known functions and are available with many different subsets of the prior art. The subset 10 as including the above components is an operational telephone which can be directly connected to a telephone line 13.

As one can ascertain from FIG. 1, the subset 10 has located on the front surface thereof an electrophoretic display 11. The display 11 may be fairly large in effective area and, for example, may be four inches by four inches or more. It is, of course, understood that the display 11 can be rectangular, square or of any geometrical configuration of adequate size. The electrophoretic display 11 is accessed, as indicated above, by means of an XY matrix and is capable of providing high resolution with a relatively large number of data lines. The display 11 is associated with an overlay 12. The overlay 12 may be a pressure or position sensitive device which, as will be explained, enables the user of the subset to implement the dialing sequence when a call is to be made. Also associated with the subset 10 are a series of mode key switches or momentary push buttons, as 15-21, which as will be explained are utilized to implement operating modes associated with the subset employing the high resolution electrophoretic display 11. The key switches can also be directly displayed on the display 11 and operate with the overlay 12 as compared to discrete keys. Hence, one such key 100 is shown by way of example in FIGS. 2 and 3. Therefore, the entire top surface of the subset housing can be a display panel only (dashed line of FIG. 1).

The main aspect of using the display 11 in conjunction with the subset 10 is to enable a user to dial various numbers and to receive data from called locations, which data can be read directly from the display. In this manner the user can utilize the subset 10 as a means for receiving graphical data or other data from various remote locations which data will be immediately displayed on the display 11 associated with the subset. It is, of course, apparent that apart from receiving data one must be able to initiate a call and utilize the subset 10 as a conventional telephone.

Essentially, as shown in FIG. 1, there is displayed on the subset, via the display 11, a replica of a conventional dialing keyboard. More particularly, FIG. 2 shows the conventional keyboard. As will be further explained, this keyboard format is generated by a microprocessor means utilizing CAD techniques whereby when a subscriber goes off hook the keyboard format is displayed. In conjunction with the pressure or position sensitive overlay 12, the user can now dial in any number desired. It is immediately understood that while a pressure sensitive overlay is described, there are many other techniques which will allow a touch overlay or touch operation, such as LED arrays or capacitive sensing devices. These devices will detect the position or pressure imparted by a user at various areas of the display, and hence, such an overlay is not directed solely to pressure.

In regard to pressure overlays, they are furnished by many companies and are conventional components. See, for example, a product distributed by Tektronix Inc. of Beaverton, Oregon, which product is marketed as an interactive touch panel. The panel essentially is capable of detecting touch or pressure with high resolution. It is rugged and reliable and of relatively low cost. Other companies, such as Hewlett Packard of California, produce systems which are designated as touch screen systems. Thus, as one can ascertain, there are many overlays, as overlay 12, which can be associated with various display panels to enable a user to implement a code or other sequence by touching an area of a screen which has been displayed.

Thus, in referring to FIG. 2 there is shown a typical telephone keyboard format which, as will be explained, is presented on the display 11 and which immediately becomes visible to the user. Thus, the user can essentially place a call by accessing the various display areas which will produce discrete signals generated by touching the various positions to enable a user to dial in a conventional manner. As indicated, FIG. 2 shows the conventional telephone keyboard of which we are all apprised of. This keyboard format, as will be explained, is generated by a microprocessor whereby when a subscriber goes off hook or de-

sires to place a call, the keyboard format, as shown in FIG. 2, would be displayed.

Referring to FIG. 3 there is shown another replica of a telephone keyboard. It is immediately noted that the numbers, as for example compared to FIG. 2, are out of order or out of sequence. In any event, as will be further explained, the ability to generate a graphic keyboard format on a display, as electrophoretic display 11, enables one to easily exchange the various positions associated with a conventional keyboard. In this manner the display 11 can generate a random format indicative of a telephone keyboard where the user can view the format and dial a number in complete secrecy. This aspect can, therefore, enable high security dialing.

As one can ascertain, there are many people who are extremely competent in determining a number dialed by a person. These people can view a person making a call from a remote location and obtain the exact number dialed by viewing the sequence of dialing as implemented on a conventional telephone keyboard. In this manner, such persons have received unauthorized codes from watching a user dial in a secure number, such as a credit card number. These codes, for example, may also include MCI, Sprint or other access codes, as well as credit card numbers, to which an unauthorized user, by viewing the person dialing, may gain access.

Based on the generation of a display indicative of a keyboard, by means of electronic techniques, one can therefore randomly exchange the conventional key positions on the keyboard display as shown, for example, in FIG. 3. Thus, this will prevent unauthorized persons from ever knowing or determining the numbers dialed due to the random nature of the keyboard display, as generated by the circuitry to be described.

Thus, as one can further ascertain, FIG. 2 shows a completely conventional keyboard which is generated and displayed on the electrophoretic display 11, while FIG. 3 shows a random arrangement of another keyboard format which can also be utilized to generate dialing pulses indicative of a telephone call.

Apart from the above described mode of operation, another mode of operation will be described when viewing FIG. 5. It is well known that modern day telephone subsets have capacity for storage in memory of a plurality of telephone numbers. Most subsets can store 10 to 15 individual numbers or more, each of which may include eleven or more digits. These telephone numbers are associated with a directory that the user himself can formulate. In this manner modern telephone subsets enable a user to dial in and store a series of frequently called numbers. These numbers can then be dialed by merely pressing one button instead of dialing the entire sequence. In certain subsets the user would dial in, for example, two digits to access an 11 digit number. Such procedures and structures for implementing such subsets are well known. In fact, many of the circuits, as well as the techniques for implementing automatic dialing for a telephone subset, are available from many sources of manufacture. See, for example, U.S. Patent No. 4,011,414 issued on March 8, 1977, entitled "Automatic Dial System for a Subscriber Telephone" to W. D. Warren and assigned to Texas Instrument Incorporated of Dallas, Texas. This is one of many companies who supply such automatic dialing systems as well as complete integrated circuits for use in telephone subsets.

As will be explained, by utilizing a telephone subset with an electrophoretic display, as display 11, one can now substantially increase the number of stored telephone numbers as the consumer need no longer rely on memory or rely on a separate written directory for determining what numbers are stored in the system. As will be explained, the display, as shown in FIG. 5, is effectively capable of displaying a plurality of stored numbers, including the name of the individual or company associated with that number. In this manner a cursor (FIG. 5) is also presented whereby the cursor can move along the listing and when the subscriber moves the cursor to the number he desires to call he can now activate or access the call by pressing a further button, such as button 21 on the subset. When the cursor is aligned at a particular telephone number the activation of button 21 causes the telephone circuitry to automatically dial the number at the cursor position. This, therefore, enables one to store hundreds of telephone numbers in local memory and to display all numbers stored. Then, by means of the cursor, the subscriber can select any one of the numbers stored and thereby immediately commence dialing.

It is further indicated that the user can rapidly scan the directory, or the telephone numbers as stored, by means of additional keys such as 17 and 18 and, hence, have rapid access to all numbers which are stored and displayed on the electrophoretic display 11 in order to initiate a dialing sequence or, for example, to look up or determine a certain number. Thus, as one can ascertain, the use of a high resolution, multiline display in conjunction with a subset will enable a user to access a large number of telephone numbers or other data. By use of the display each number will be associated with a particular company or individual to thereby enable such a user to commence a rapid dialing sequence without any further access to the telephone keyboard. The directory consists of multiple data pages where each page can be

addressed by means of a mode key on the subset. Hence, a listing of hundreds of telephone numbers displayed as 50 or more at one time is accommodated.

Referring to FIG. 4, there is shown a detailed block diagram of the circuitry included within the telephone subset, such as subset 10 of FIG. 1. The telephone subset includes a controller or microprocessor 25. As one can ascertain, in today's technology there are many very powerful microprocessors which are commercially available. Certain microprocessors, for example, are capable of processing 32 bit words and are manufactured by many companies. See, for example, the microprocessor manufactured by Intel, Inc. as the 80386. The Motorola Corporation manufactures a microprocessor designated as the 68020 while the Zilog Company manufactures a microprocessor designated as the Z80000CPU. For further examples of suitable microprocessors, reference is made to a text entitled "32-bit Microprocessors" by H.J. Mitchell, published by the McGraw Hill Book Company (1986). In that text there is not only shown the structure of such microprocessors or controllers 25 but many of the applications associated with such devices.

The microprocessor or controller 25 is coupled to a mode selector module 26 which mode selector module interfaces with certain of the buttons or keys, as 15-20, associated with the telephone subset of FIG. 1. The mode selector 26, as will be further explained, can be implemented by programming the microprocessor in a well known manner.

In any event, the microprocessor 25 is typically associated with a random access memory or RAM 26 and a read only memory or ROM 27. Stored in the ROM are XY patterns indicative of a particular keyboard format, such as the keyboard shown in FIGS. 2 or 3 as well as others. The output of the ROM and RAM are coupled to a keyboard display module 30 which, essentially, controls an X decode and driver module 31 and a Y decode and driver module 32.

As indicated above, the display 11, which is an electrophoretic display, is addressed by means of an XY matrix arrangement. This is a common access technique for many memory and display devices. Thus, as one can ascertain, the X and Y decode and driver modules 31 and 32 are coupled to suitable terminals of the electrophoretic display 11. Hence, by the use of XY addressing, one can generate any type of display on the display 11 which will be visualized by the user.

As will be further explained, when the user implements a call he normally takes the handset 14 and places it in an off hook condition. This off hook condition is detected by means of an off hook detector 31 which, therefore, indicates to the controller or microprocessor 25 that a call is to be made. The controller 25 then accesses the suitable memory addresses of the ROM and RAM and displays the keyboard format shown in FIG. 2, for example. This, of course, is a conventional keyboard display. The keyboard format is, therefore, visually displayed to the user and, as indicated above, is associated with a position or pressure sensitive transparent overlay 12. Thus, the user then, by accessing the various areas of the display, can dial a number in a conventional manner. The exact dialing technique, and so on, will be explained subsequently.

In any event, if the user desires a high security mode, in which a random keyboard portrayal is to be provided, he may then activate access button 20 informing the mode selector to activate a random generator sequence indicative of module 32. In any event, one can generate a display, as for example shown in FIG. 3, by means of utilizing a random generator to randomly place the digits 0 to 9 in any location on the graphic keyboard display. However, it is also understood that a certain number of keyboard formats can be directly stored in ROM memory 27 and, hence, the user would have access, for example, to five different keyboards and by pressing key 20 any one of the different five keyboard would randomly appear. In any event, this will again allow the user to commence a dialing sequence. Such a random generator format is associated with ROM and RAM memory locations to enable the keyboard display 30 to present the format shown in FIG. 3 or any other format. The dialing sequence is decoded by the dial decoder 50 which is controlled by the microprocessor 25 according to the displayed graphic keyboard format.

Actually, the user will commence a dialing sequence which, essentially, would allow the telephone switching system to gain access to the dialed number. The system detects a ring back via the ring back detector 32 to thereby extinguish the display of the keyboard format to ready the subset display 11 for receiving data, if that is desired. In any event, if the user does not wish the display to be erased then the user can indicate this by pressing a save button also associated with the subset. There is also shown a data display buffer 60 which will be explained.

FIG. 6 shows a block diagram indicating the further implementation of the various features, as described above. Essentially, the subset 10 may be associated with a pressure sensitive overlay 12 or any other type of touch or position overlay, as is well known in the art. The overlay 12 is coupled to a dial or TTMF generator 40 which includes dial decoder circuitry 50 of FIG. 1. The dial or TTMF generator 40 is a well known module and is avail-

able from many companies in integrated circuit form. The generator 40 converts the various switch positions associated with the display 11 to suitable frequencies or dial pulses to be transmitted over the telephone line 50 by means of conventional circuitry including the buffer or isolation amplifier 41. The dial or TTMF generator 40 includes a digit counter 42 coupled to the microprocessor 25 to determine each digit dialed for providing the proper timing. This is also well known. The telephone line is normally associated with a suitable buffer, which is available from many sources as well. The buffer 50 may contain storage and other suitable devices enabling one to transmit stored telephone numbers and thereby transmit the same over the conventional transmit or tip (TX) and receive or ring (RX) lines associated with the telephone line.

Also shown in FIG. 6 is the fact that the receive line RX is associated with a separate data buffer designated by reference numeral 60 and also shown in FIG. 1. The function of the data buffer 60 is to store incoming data and to direct the data to the RAM 26 or other memory sections of the microprocessor or controller 25. It is, of course, understood that such microprocessors can receive multiple inputs from various devices on real time input/output (I/O) buses. The microprocessor, as programmed, will then determine the nature of the data, as stored in data buffer 60, in order to properly activate the keyboard display 11 to enable the display of the proper data and to decode the data according to the incoming data format. As indicated, and can be ascertained from the above referenced U.S. Pat. No. 4,655,897, an electrophoretic display has extremely high resolution and such displays have been developed which are greater than 8-1/2 inch by 11 inch in area. See also a copending application entitled "ELECTROPHORETIC DISPLAY PANEL APPARATUS AND METHODS THEREFOR" filed on November 19, 1985, Ser. No. 799,458 for Frank J. DiSanto et al. and assigned to the assignee herein. Hence, the amount of data, as well as the resolution, can accommodate information of all sorts.

Thus, as can be ascertained from the above, the electrophoretic display, which has been described in U.S. Patent No. 4,655,897, is a high resolution display which does not require power for refreshing or storing data therein once the data is written. Essentially, by utilizing such a display, one can now generate a visual presentation of a telephone keyboard to enable a user to dial any desired number in conjunction with a position sensitive transparent overlay. It is, of course, understood that the keyboard format can be changed according to the desires of a user. Furthermore, by the use of such a high resolution display the telephone subset is now capable of storing a great many telephone numbers which can be displayed in terms of pages, for example, perhaps 10 or 50 telephone numbers on each page. The entire memory storage contents can be displayed and employed in conjunction with a movable cursor. In this manner, the subscriber can now see each telephone number stored in memory and also knows the entity to which the telephone number belongs. By moving the cursor he can now select the telephone number he wishes to access and by merely pressing one of the subset keys can dial that number without ever accessing the displayed keyboard mode. In this way the subscriber does not have to provide any individual or separate record of stored telephone numbers as is implemented in present day conventional telephone systems.

The entire mechanism for operating in the directory mode is again implemented by pressing a mode key associated with the mode selector 26. In this manner the mode selector 26, for example, upon the depression of subset switch 15, will again inform the microprocessor 25 that it is desired to display all telephone numbers stored in memory. The microprocessor 25 will then access the RAM or ROM 26 and 27 and cause the stored data, indicative of stored telephone numbers, to be presented to the keyboard display 30 which is also under control of the microprocessor. The keyboard display 30 generates the various alphanumeric characters as including a character generator which will convert the stored digital data into analog numerals, as is well known in the prior art, and hence display telephone numbers on the electrophoretic display 11.

At the same time a cursor is generated, which cursor can be moved along the directory display (FIG. 5) by means of additional subset buttons or keys. The cursor can be moved in an up or down direction as, for example, the cursor on a computer screen. Techniques for moving cursors to any location are well known. When the cursor is adjacent a desired number the user then merely presses a dial number key on the subset and the telephone number that the cursor is next to or aligned with, as shown in FIG. 5, is automatically dialed.

The above-noted techniques can be simply implemented by means of conventional programming and one skilled in the art should have absolutely no difficulty in displaying such stored numbers as, for example, according to the format depicted in FIG. 5. It is, of course, understood that many modern telephone sets have the ability to store numbers and the numbers stored, which for example may be 10 or more numbers, can be accessed and displayed directly on a single line LCD display or other type of display associated with present day telephone subsets.

The telephone subset of FIG. 1 also has an

additional button or key which may be, for example, button 19. By pressing button 19 the telephone is now operated in a proprietary manner. For example, by depressing display button 19 the following sequence of events occur. The depression of button 19 informs the mode selector 26 to prompt the microprocessor 25 that a request is made to implement the generation of a keyboard display. The telephone user then dials in a four digit number, which is like a PIN number, as the same type of number as employed in conjunction with cash machines or credit card systems. The computer 25 compares the dialed in PIN number with a previously stored number and will indicate that the subscriber has access to confidential information contained in given memory locations of the read only memory 27. This information, for example, would present, on the display 11, all credit card numbers which belong to the possessor of the secret code. This will, therefore, enable the user to place calls to enable him to order various goods by means of the telephone subset 10. In any event, he is provided with a separate display contained in a separate memory location of all his credit card numbers.

The display also includes pertinent telephone numbers associated with those credit cards. For example, the number which he can call in regard to a missing or lost credit card, and so on. This data is easily stored in memory and, again, is accessible by means of the same techniques as described above.

Certain other features are immediately apparent and can be implemented with the exact circuitry shown in FIG. 4. For example, the above-noted system lends itself to furnishing a privacy phone lock. The operation would be as follows. With the handset 14 on hook, as shown in FIG. 1, the unit displays a simple array of characters which is not a keyboard format. These characters are stored in a reserved memory block and, essentially, are displayed on the electrophoretic display each time the handset is on hook. The electrophoretic display consumes no power once an array is written on the display. The user then must take the phone off hook and select a proper code via the characters displayed in the array to obtain a dial tone. Once the proper code is entered, a dial tone will be provided and the telephone keyboard display will be properly displayed. Otherwise no line connection can be made and one could not access the telephone line without having access to the code which may be implemented by means of the simple array of characters displayed on the display 11 when the hand set 14 is on hook.

It is, of course, understood that based on conventional techniques the telephone display 11 can also store and display a history of telephone usage, for example, the user code, the number dialed, the data, the time, the length of the call and so on. These techniques are, of course, incorporated in presently available commercial equipment, as well as being extensively described in the prior art.

Hence, it should be apparent to one skilled in the art that the provision of a high resolution display in conjunction with a telephone subset will provide many advantageous modes of operation which modes should be, as described above, understood by those skilled in the art.

Referring to FIG. 7 there is shown a detailed block diagram showing a telephone subset 10, as described above, employing an electrophoretic display panel 11 which is employed for data and graphics display. It is immediately noted that FIG. 7 retains the same reference numerals as previously described in conjunction with the above-noted figures. For example, in FIG. 7, there is shown the electrophoretic panel 11 which is coupled to X drive and Y drive circuits via panel control module designated as 31 and 32. The panel control is analogous to controls 31 and 32 of FIG. 4. As seen, the panel control is also coupled to a character generator 30 which essentially is coupled to the microprocessor 25 via a bidirectional address bus. Character generators for converting digital data into alphanumeric characters are also well known, as indicated in conjunction with FIG. 4, and can be implemented by the programming of the microprocessor 25.

Also shown is the overlay control designated by numeral 40. Essentially, as indicated, the overlay, which may be a pressure sensitive or other type of overlay, is coupled directly to a dial or TTMF generator 40 (FIG. 6). This again can be implemented by microprocessor programming. The overlay control 40 is also associated with additional circuitry for operating in different modes. As one can ascertain, the mode selector 26 will select and inform the microprocessor in regard to the mode of operation and interfaces with the microprocessor, as shown in FIG. 7, as controlled by means of the subset switches, as 15-20 of FIG. 1. Also shown is the PROM or ROM 27 and the RAM 26.

In any event, as indicated above, the entire subset normally interfaces with a conventional telephone line designated (PSTH) by means of a telephone interface 70, which is shown coupled to the handset 14 as part of subset 10. The telephone interface may include the remaining telephone circuitry, as well as various other registers and so on for data operation.

As seen, the entire unit is associated with a separate facsimile modem 60 which is one of many different types of available modems capable of receiving various types of facsimile transmissions, such as groups I, II, III. Such modems for convert-

ing facsimile transmissions into graphic data are well known and coupled to the fax modem 60 is a fax graphics controller 61 which converts the facsimile transmissions into suitable graphics to be applied to the panel control circuit 31 and then displayed directly on the panel 11 associated with the subset. Also shown is a modem control module 72 which is coupled to the fax modem 60 and which receives instructions from the control bus of the microprocessor 25 to enable proper operation. There is a modem selector 71 which essentially is a conventional component and which determines the exact nature of the facsimile transmission to allow proper decoding.

Hence, as shown in FIG. 7, and as above described, telephone apparatus can operate as a complete data subset whereby facsimile messages can be displayed directly on the display 11 and, for example, such a display can accommodate 500 or more lines of individual graphics, employing conventional facsimile modules and modems. In this manner the entire subset, based on its use in conjunction with a high resolution display, has great capabilities and versatilities as should be apparent to those skilled in the art when reviewing the above-noted specification.

Claims

1. A telephone subset apparatus for use in providing high quality data displays, comprising:
a telephone subset including a housing having a telephone handset coupled thereto,
a high resolution display panel means mounted on said top surface of said housing and capable of being accessed by an X-Y addressing means to display graphic data in a plurality of lines,
microprocessor means coupled to said display panel and operative to cause said panel to provide a graphic presentation of a telephone keyboard arrangement according to said X-Y addressing means,
position sensitive means coupled to said panel and operative when accessed to produce a telephone number output signal as dialed by a user employing said graphic keyboard presentation as a guide for selecting said number.

2. The telephone subset apparatus according to Claim 1, wherein said display panel means includes an electrophoretic display.

3. The telephone subset apparatus according to either preceding claim 1 or 2, wherein said microprocessor means includes an X decoder means coupled to said display and addressed by said microprocessor means to generate X data for said display and a Y decoder means coupled to said display and addressed by said microprocessor to generate Y data for said display.

4. The telephone apparatus according to any one of the preceding claims 1 to 3, wherein said microprocessor means includes first storage means coupled thereto and operative to store data indicative of various graphic keyboard presentations to enable a user to dial a telephone number based on any one of a different number of said keyboard presentations.

5. The telephone subset apparatus according to Claim 4, further including means coupled to said handset and operative to provide a control signal when said handset is lifted off hook.

6. The telephone subset apparatus according to Claim 5, including means coupled to said microprocessor means and responsive to said control signal to cause said microprocessor to generate any one of said various graphic keyboard presentations as stored.

7. The telephone subset apparatus according to any one of the preceding claims 1 to 6, further including interface means coupled to said display panel means for coupling said display panel means to a telephone line.

8. The telephone subset apparatus according to Claim 7, wherein said interface means further includes a dialing generator coupled to said position sensitive means and operative to provide telephone dialing signals to said telephone line.

9. The telephone subset apparatus according to any one of the preceding claims 1 to 8, further including a plurality of actuatable keys mounted on the top surface of said housing and coupled to a mode selector means included in said microprocessor means for operating said microprocessor means in any one of a plurality of modes according to the selection of an associated key for said mode.

10. The telephone subset apparatus according to Claim 9, further including second storage means operative to store therein a plurality of telephone numbers indicative of called parties, said second storage means accessed by a first one of said mode keys to cause said display to display a first plurality of stored numbers simultaneously thereon, and cursor means associated with said display and operative to movably align adjacent each number as displayed under control of said user by at least a second one of said keys to enable a user to select any one of said displayed numbers, and means coupled to a third one of said keys to cause the number aligned with said cursor to be dialed.

11. The telephone subset apparatus according to Claim 10, wherein said plurality of numbers as stored are displayed in consecutive display presentations to thereby store a large directory of telephone numbers which are displayed in groups of numbers on a page-to-page basis.

12. The telephone subset apparatus according to any one of the preceding claims 9 to 11, further including third storage means coupled to said microprocessor means and operative to store therein a plurality of credit card numbers associated with a user of said subset and accessible by means of a fourth subset mode key to provide said user with a display indicative of said credit card numbers.

13. The telephone subset apparatus according to Claim 12, further including means coupled to said display and operative when said handset is on hook to provide an array of separate characters wherein said subscriber can access said sthird storage means only by first selecting a given set of characters in said displayed array.

14. The telephone subset apparatus according to Claim 4, wherein said first storage means includes a ROM and a RAM.

15. The telephone subset apparatus according to any one of the preceding claims 1 to 14, further including means coupled to said display means for generating a display of telephone usage.

16. The telephone subset apparatus according to Claim 7, wherein said interface means includes means for receiving facsimile transmissions from said telephone line and for converting said transmissions to graphic data for display by said display panel.

17. The telephone subset apparatus according to Claim 16, further including a data buffer means coupled to said telephone line for storing received data prior to processing the same said data buffer means coupled to said microprocessor means.

18. The telephone subset apparatus according to Claim 17, further including ring-back detector means coupled to said telephone line and operative to provide a control signal when a connection is made between said subset and a called party by detecting ring back, with said detector coupled to said microprocessor means to enable said microprocessor to ready said subset for the receipt of data from said called party.

19. The telephone subset apparatus according to any one of the preceding claims 1 to 18, wherein said position sensitive means includes a pressure sensitive overlay which overlay is positioned over said display and provides position sensitive output signals according to the area of said display contacted by a user exerting pressure thereat.

20. The telephone subset apparatus according to any one of the preceding claims 1 to 19, wherein said microprocessor means includes character generator means operative to convert digital data as stored to alpha numeric character data for addressing said X-Y display.

21. A telephone subset apparatus characterised by an interactive display by which means a telephone number can be interactively selected to output a corresponding signal from said apparatus to place a call.

22. The telephone subset apparatus according to claim 21, wherein different modes of display may be presented upon said interactive display, which modes can be interactively selected by a user touching said interactive display.

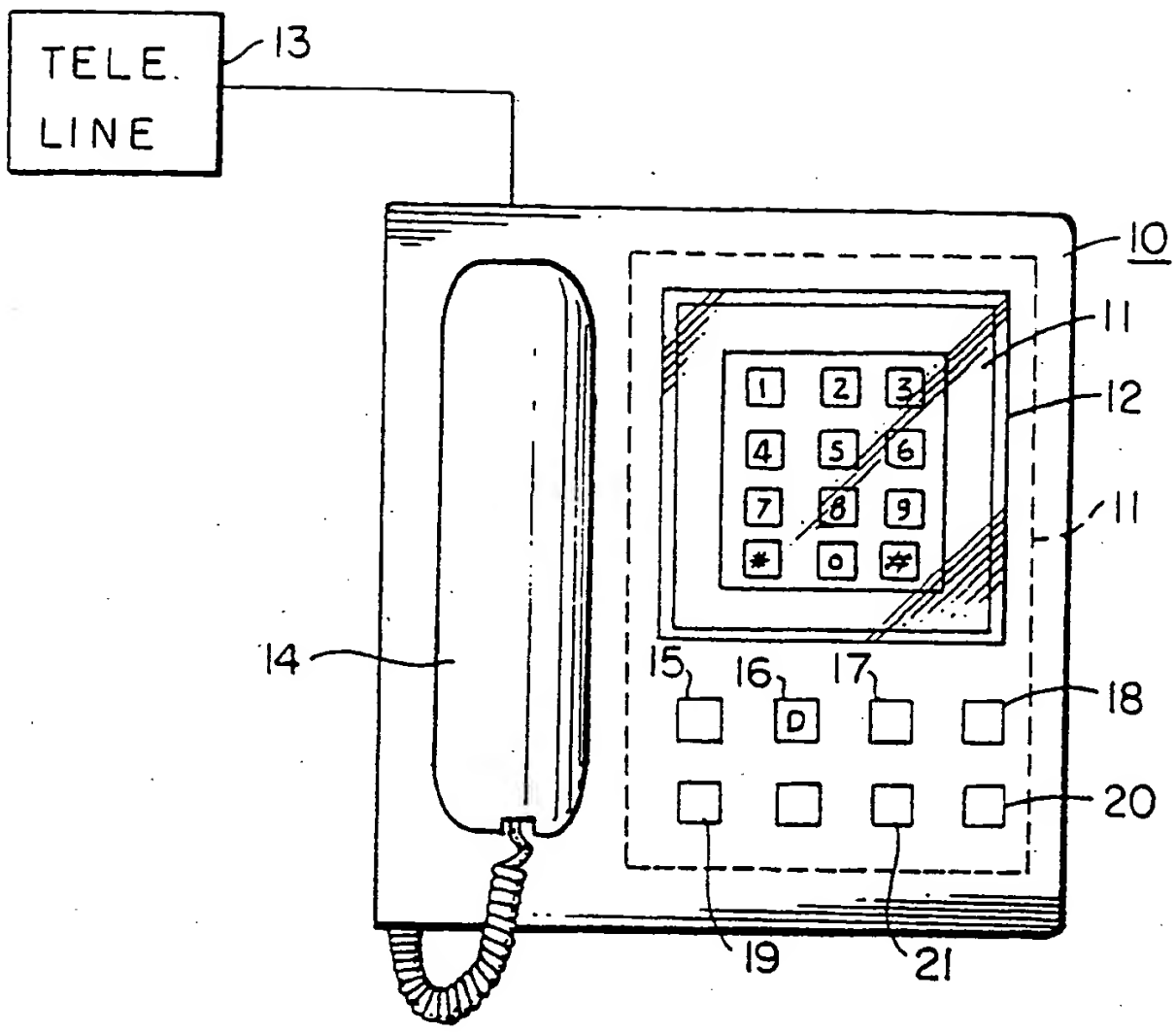

FIG. 1

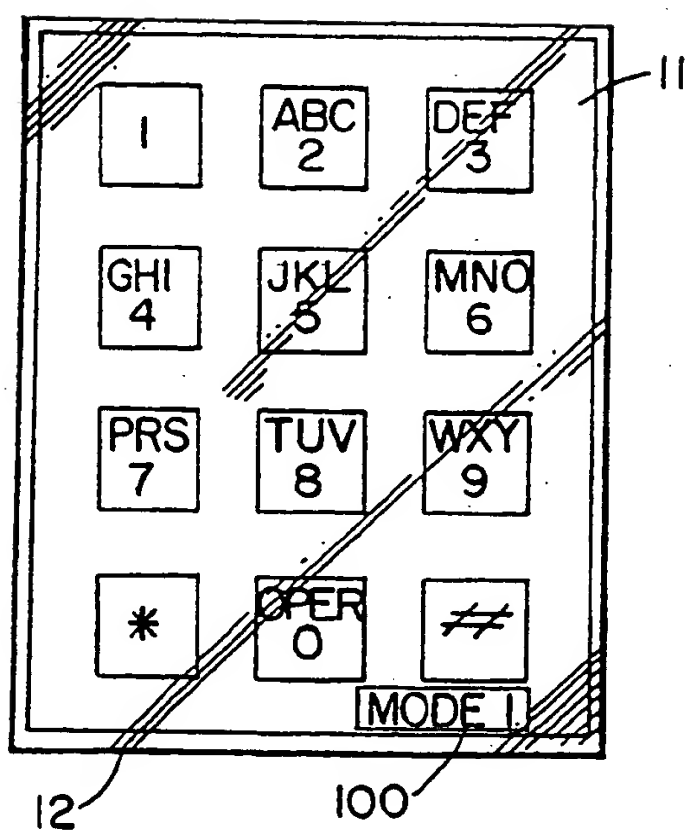

FIG. 2

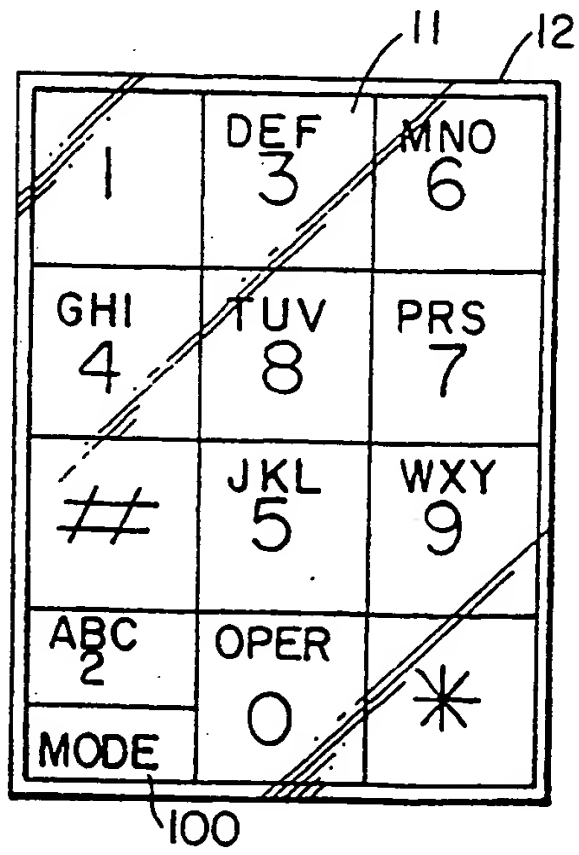

FIG. 3

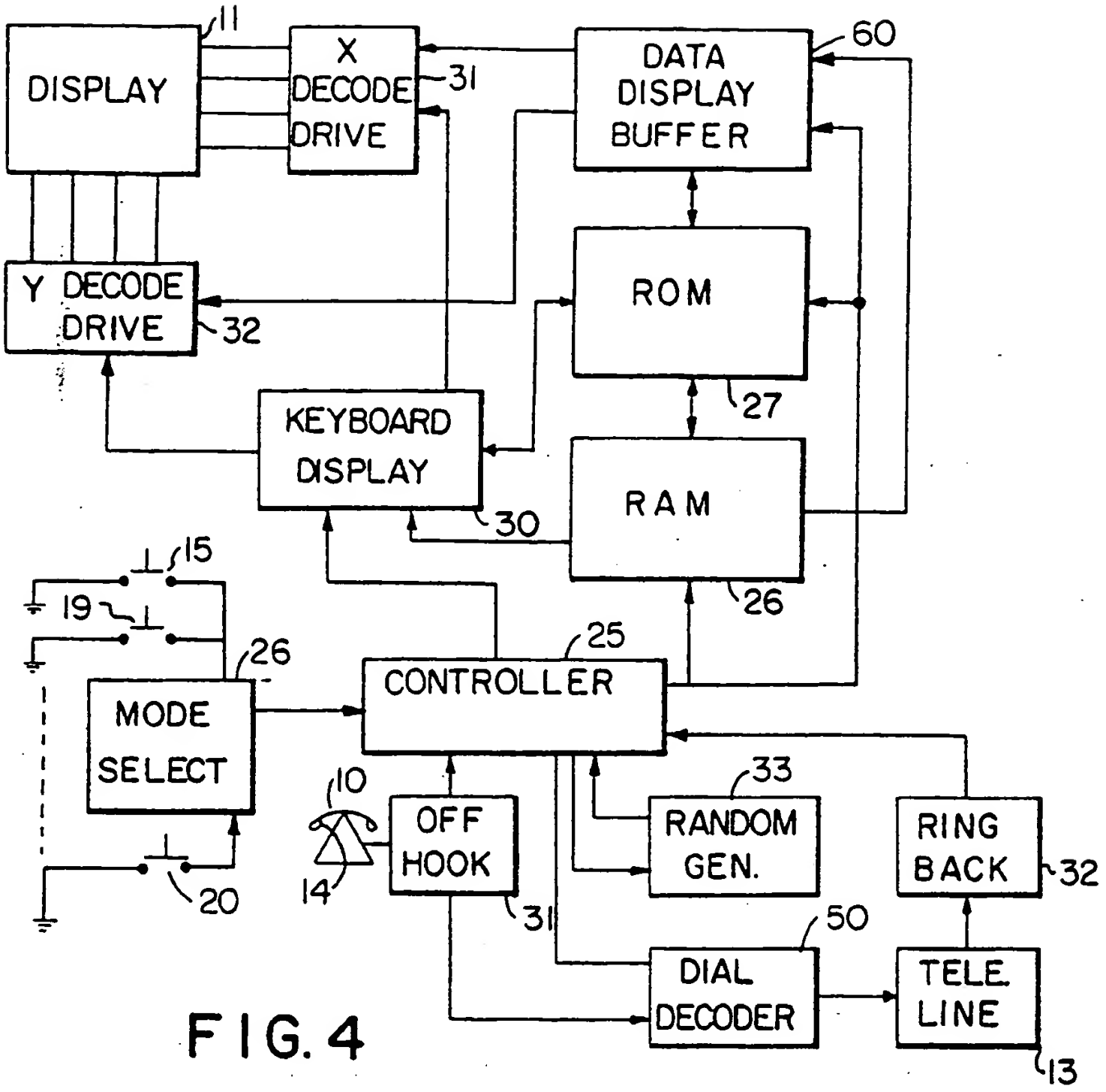
DISPLAY
11
X DECODE DRIVE
31
DATA DISPLAY BUFFER
60
Y DECODE DRIVE
32
ROM
27
KEYBOARD DISPLAY
30
RAM
26
15
19
26
MODE SELECT
20
25
CONTROLLER
10
14
OFF HOOK
31
33
RANDOM GEN.
RING BACK
32
50
DIAL DECODER
TELE. LINE
13

FIG. 4

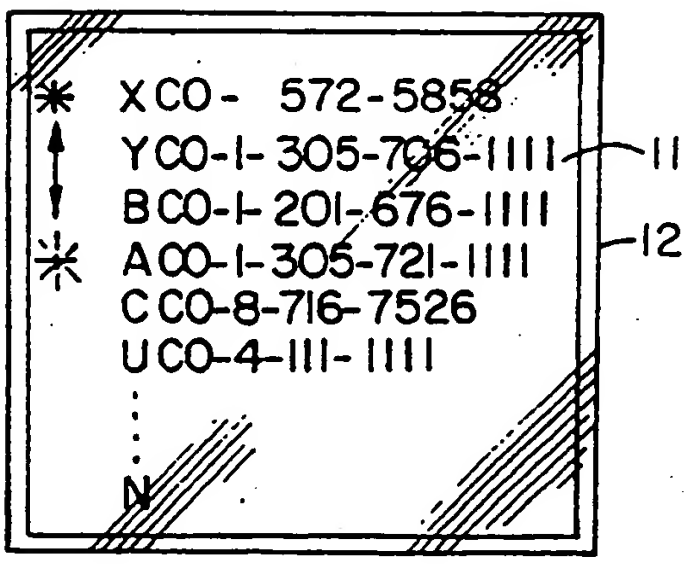
XCO- 572-5858
YCO-1-305-706-1111
BCO-1-201-676-1111
ACO-1-305-721-1111
CCO-8-716-7526
UCO-4-111-1111
N
11
12

FIG. 5

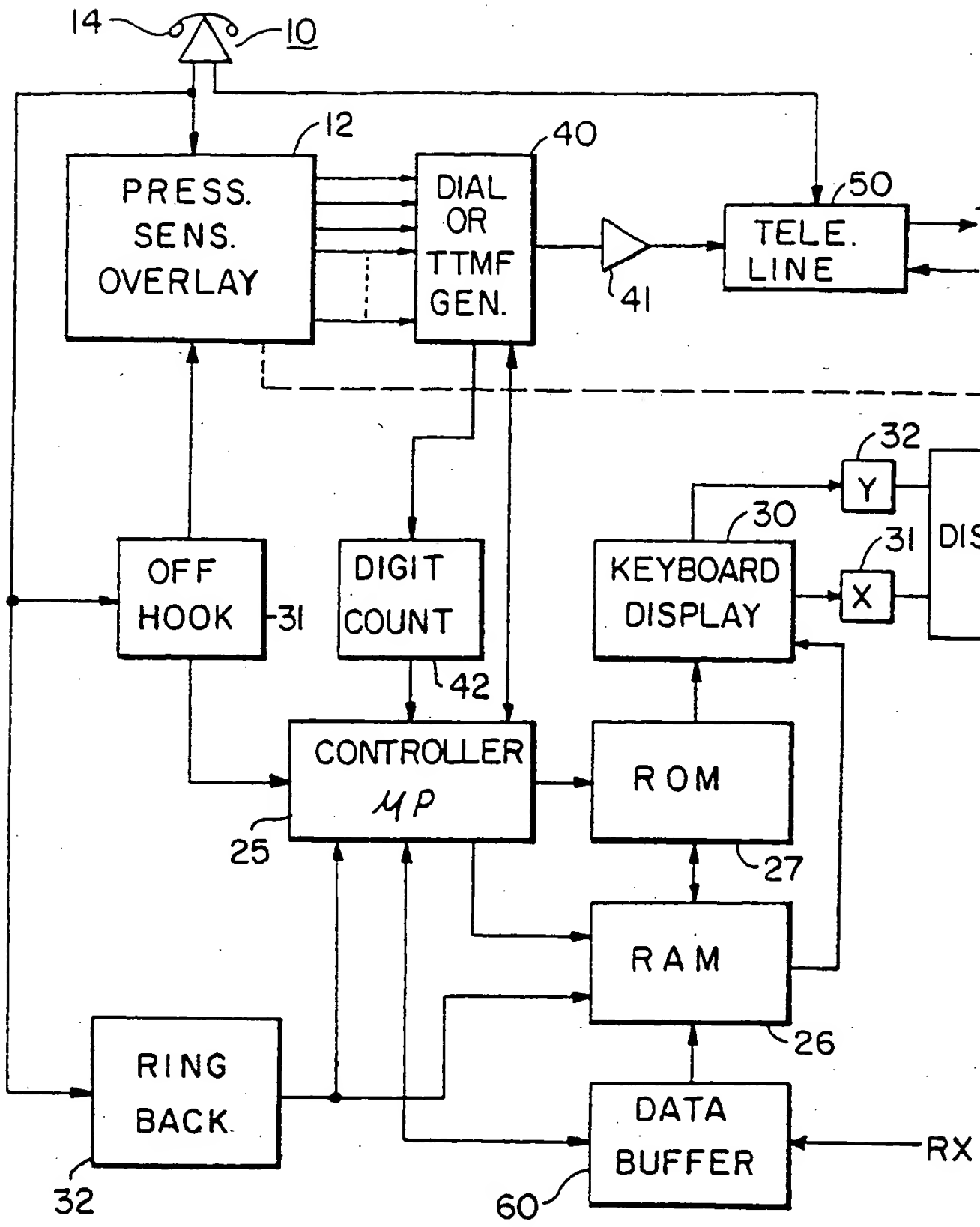
14
10
12
PRESS. SENS. OVERLAY
40
DIAL OR TTMF GEN.
41
50
TELE. LINE
TX
RX
11
32
Y
30
31
X
DISPLAY
KEYBOARD DISPLAY
OFF HOOK
31
DIGIT COUNT
42
CONTROLLER μP
25
ROM
27
RAM
26
RING BACK
32
DATA BUFFER
60
RX

FIG. 6

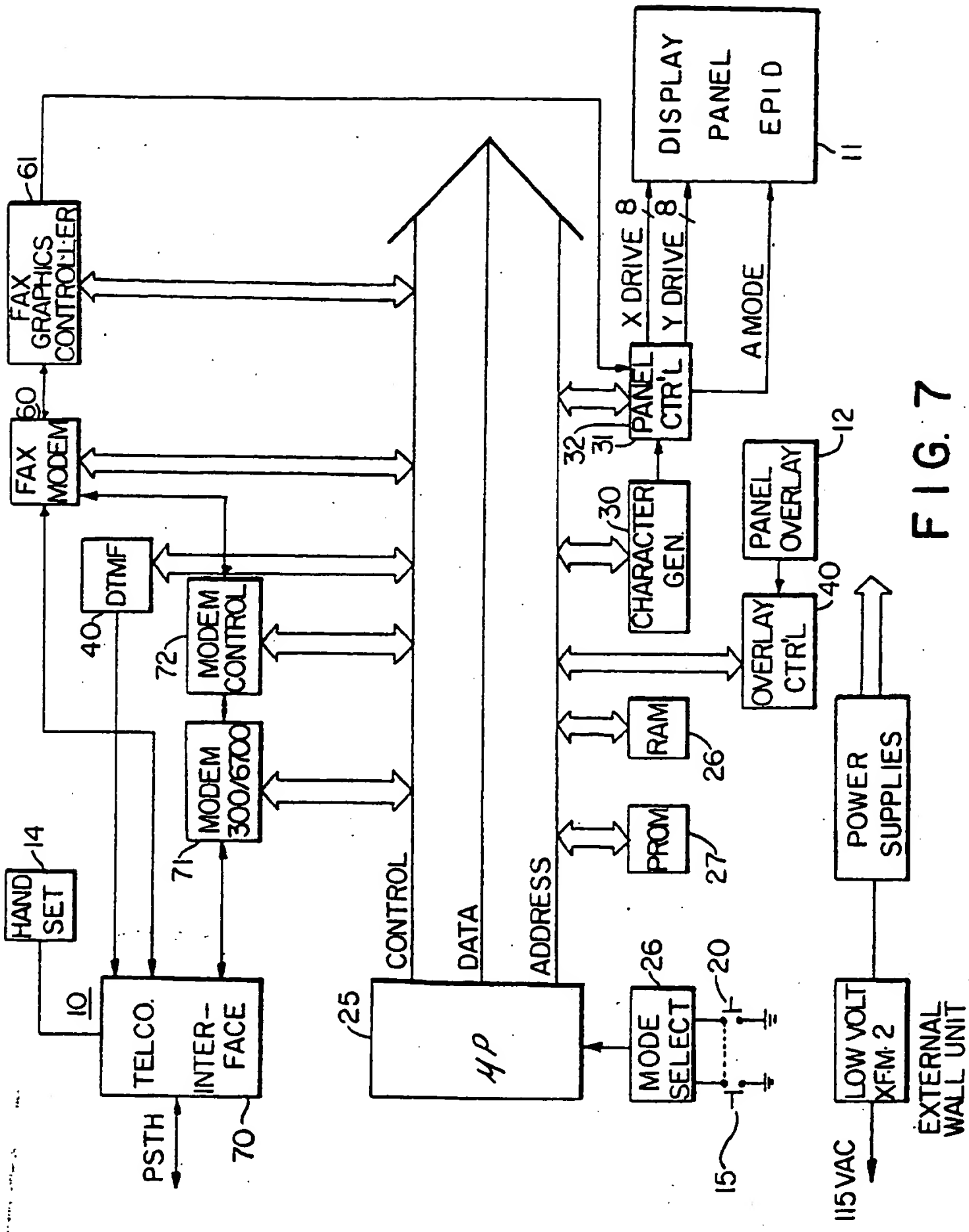
DISPLAY PANEL EPI D
11
61
FAX GRAPHICS CONTROLLER
60
FAX MODEM
DTMF
40
72
MODEM CONTROL
MODEM 300/6700
71
HAND SET
14
10
TELCO. INTER-FACE
PSTH
70
X DRIVE 8
Y DRIVE 8
A MODE
PANEL CTR'L
32
31
30
CHARACTER GEN.
PANEL OVERLAY
12
OVERLAY CTR'L
40
RAM
26
PROM
27
CONTROL
DATA
ADDRESS
25
μP
MODE SELECT
26
20
15
POWER SUPPLIES
LOW VOLT XFM. 2
115 VAC
EXTERNAL WALL UNIT

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 9376

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	IEEE COMMNICATIONS MAGAZINE, vol. 23, no. 2, February 1985, pages 21-26, IEEE, New York, US; R. HSING et al.: "An interactive touch phone for office automation" * Page 2, left-hand column, line 5 - page 25, right-hand column, line 31; figures * ---	1,3,5-8,14,15,19-22	H 04 M 1/274 H 04 M 1/23 H 04 M 1/66
A	IDEM ---	2,9-11	
X	WO-A-8 800 371 (NEWEX INC.) * Page 6, line 8 - page 9, line 28; figures 1-13 * ---	1,3,5-11,14,15,19-22	
A	---	16,17	
X	GB-A-2 156 186 (INTERNATIONAL STANDARD ELECTRIC CORP.) * Page 1, line 67 - page 3, line 60; figures 1-5 * ---	1,3,5-8	
Y	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 39 (E-381)[2096], 15th February 1986; & JP-A-60 194 859 (MITSUBISHI DENKI K.K.) 03-10-1985 * Abstract * ---	1,3,6-9,14,15,19-22	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H 04 M G 06 F G 02 F
A	IDEM ---	10,11	
Y	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 268 (E-436)[2324], 12th September 1986; & JP-A-61 90 577 (HITACHI LTD) 08-05-1986 * Abstract * --- -/-	1,3,6-9,14,15,19-22	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-05-1990	DELANGUE P.C.J.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 9376

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 175 429 (TI (GROUP SERVICES) LTD) * Whole document * ---	1,2	
A	GB-A-2 154 393 (STANDARD TELEPHONES AND CABLES PUBLIC LTD) * Whole document * -----	1,3	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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European Patent Office
Office européen des brevets

(11) Publication number : **0 417 362 B1**

B9

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(45) Date of publication of patent specification : **10.05.95 Bulletin 95/19**

(51) Int. Cl.[6] : **H04M 1/274**, H04M 1/23, H04M 1/66

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(54) Data/facsimile telephone subset apparatus incorporating electrophoretic display.

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Description

BACKGROUND OF THE INVENTION

This invention relates generally to a telephone subset and more particularly to a data/facsimile telephone subset which employs a high resolution electrophoretic display.

In the present technology there are many telephones or subsets which are available, which phones are associated with various display devices. Many telephones incorporate LCD displays which can, for example, display the time of day, the date, as well as the telephone number which is dialed. Certain of these displays will also give an indication of how long the conversation lasts by providing a timing means which is also viewable on the display. Such telephones or subsets, which are available from many sources, are widely employed in present day use and essentially the display normally consists of a line of data such as, for example, the displays can display a telephone number as a single telephone number or may display a date and time of day. There are other telephone subsets which are available at airports, motels and so on and which have a more complete display as, for example, a CRT display or a gas discharge display.

These telephones can be employed for many different purposes and provide a consumer or a caller with visual data allowing him to coact with the telephone subset or with the telephone company through the data displayed. Hence, it is apparent that the prior art is replete with telephone subsets of various sorts which include various displays.

Recently, the assignee herein, namely, Copytele of Huntington Station, has developed and demonstrated a high resolution electrophoretic display which display is extremely thin and has the capability of providing a large number of lines to provide excellent resolution. For an example of such a display, reference is made to U.S. Patent No. 4,655,897 which issued on April 7, 1987 to Frank J. DiSanto and Denis A. Krusos and entitled "Electrophoretic Display Panels and Associated Methods". The patent discloses an electrophoretic display apparatus which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line patterns is filled in with an electrophoretic dispersion containing chargeable pigment particles. When a voltage is impressed between the X and Y lines pigment particles, which are located in wells or depressions between the X and Y pattern, are caused to migrate towards the conductive plate and are deposited upon the conductive plate in accordance with the bias applied to the X and Y line conductors. There is described various electrophoretic dispersions which are suitable for operating with the display, as well as techniques for fabricating the display. In this manner such displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution at very low power.

Prior art telephone subset systems which incorporate a display panel are known in the art. Such a system is disclosed in an article entitled "An Interactive Touch Phone for Office Automation" appearing in Vol. 23, No. 2 of IEEE Communications Magazine (February 1985). The system disclosed therein includes a low resolution display panel, a telephone handset, a microprocessor operative to cause the panel to display a graphical representation of a telephone keyboard, and a position sensitive means positioned on the display which is operative to produce a telephone number output signal when accessed by a user employing the graphical representation as a guide. Insofar as the system permits a person standing nearby to observe any sequence of numbers dialed by the user in such a fashion, however, there is the opportunity for phone card identification numbers to be observed and subsequent authorised use thereof.

PCT Application WO 88/00371, published January 14, 1988 and entitled PERIPHERAL CONTROLLER also teaches that a plurality of graphic keyboard presentations corresponding to telephone dialing menus and the like can be displayed on a touch sensitive keypad display means. This system, however, also fails to teach the use of a random keypad presentation in order to prevent unauthorised persons from observing the numbers entered thereby.

U.K. Patent Application 2,156,186A to Laube, published Oct. 2, 1985 and entitled COMMUNICATION TERMINAL, teaches a videotex graphics data transmission system which includes a flat panel display screen having a transparent electrically conductive overlay, a microprocessor and an interface means for coupling the display panel to a telephone line. The display provides a telephone dialing keypad whereby the user can dial a number and transmit or receive videotex graphic data. Laube does not, however, address the issue of unauthorised access to the number being dialed by the user.

It is therefore a concern of the present invention to provide a telephone subset which incorporates, on a major surface thereof, an electrophoretic display as the type described in U.S. Patent No. 4,655,897.

It is a further concern to provide an improved data telephone subset which can be employed for various purposes due to the high resolution electrophoretic display associated therewith.

In accordance with the invention there is provided

a telephone subset apparatus as set out in claim 1.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

A telephone subset apparatus for use in providing high quality data displays, comprising a telephone subset including a housing having a telephone handset coupled thereto, a high resolution display panel means mounted on said top surface of said housing and capable of being accessed by an X-Y addressing means to display graphic data in a plurality of lines, microprocessor means coupled to said display panel and operative to cause said panel to provide a graphic presentation of a telephone keyboard arrangement according to said X-Y addressing means, position sensitive means coupled to said panel and operative when accessed to produce a telephone number output signal as dialed by a user employing said graphic keyboard presentation as a guide for selecting said number.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a top plan view of a telephone subset having an electrophoretic display according to this invention.

FIG. 2 is a diagram depicting a particular type of graphic keyboard format which can be employed in conjunction with the subset of FIG. 1.

FIG. 3 is a schematic diagram depicting another type of graphic keyboard format.

FIG. 4 is a block diagram showing a telephone subset operating in conjunction with a display according to this invention.

FIG. 5 is a diagram depicting another type of display which can be employed with this invention.

FIG. 6 is a detailed block diagram depicting the operation of the subset according to this invention.

FIG. 7 is a system schematic diagram showing the use of the telephone subset in both a data and telephone mode.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 there is shown a telephone subset 10 which includes a handset 14 normally including a transmitter and receiver portion. Essentially, the entire mechanism for the subset, including the transmitter and receiving portion, as well as the various circuitry to activate ringing and so on, are well known functions and are available with many different subsets of the prior art. The subset 10 as including the above components is an operational telephone which can be directly connected to a telephone line 13.

As one can ascertain from FIG. 1, the subset 10 has located on the front surface thereof an electrophoretic display 11. The display 11 may be fairly large in effective area and, for example, may be four inches by four inches or more. It is, of course, understood that the display 11 can be rectangular, square or of any geometrical configuration of adequate size. The electrophoretic display 11 is accessed, as indicated above, by means of an XY matrix and is capable of providing high resolution with a relatively large number of data lines. The display 11 is associated with an overlay 12. The overlay 12 may be a pressure or position sensitive device which, as will be explained, enables the user of the subset to implement the dialing sequence when a call is to be made. Also associated with the subset 10 are a series of mode key switches or momentary push buttons, as 15-21, which as will be explained are utilized to implement operating modes associated with the subset employing the high resolution electrophoretic display 11. The key switches can also be directly displayed on the display 11 and operate with the overlay 12 as compared to discrete keys. Hence, one such key 100 is shown by way of example in FIGS. 2 and 3. Therefore, the entire top surface of the subset housing can be a display panel only (dashed line of FIG. 1).

The main aspect of using the display 11 in conjunction with the subset 10 is to enable a user to dial various numbers and to receive data from called locations, which data can be read directly from the display. In this manner the user can utilize the subset 10 as a means for receiving graphical data or other data from various remote locations which data will be immediately displayed on the display 11 associated with the subset. It is, of course, apparent that apart from receiving data one must be able to initiate a call and utilize the subset 10 as a conventional telephone.

Essentially, as shown in FIG. 1, there is displayed on the subset, via the display 11, a replica of a conventional dialing keyboard. More particularly, FIG. 2 shows the conventional keyboard. As will be further explained, this keyboard format is generated by a microprocessor means utilizing CAD techniques whereby when a subscriber goes off hook the keyboard format is displayed. In conjunction with the pressure or position sensitive overlay 12, the user can now dial in any number desired. It is immediately understood that while a pressure sensitive overlay is described, there are many other techniques which will allow a touch overlay or touch operation, such as LED arrays or capacitive sensing devices. These devices will detect the position or pressure imparted by a user at various areas of the display, and hence, such an overlay is not directed solely to pressure.

In regard to pressure overlays, they are furnished by many companies and are conventional components. See, for example, a product distributed by Tektronix Inc. of Beaverton, Oregon, which product is marketed as an interactive touch panel. The panel essentially is capable of detecting touch or pressure

with high resolution. It is rugged and reliable and of relatively low cost. Other companies, such as Hewlett Packard of California, produce systems which are designated as touch screen systems. Thus, as one can ascertain, there are many overlays, as overlay 12, which can be associated with various display panels to enable a user to implement a code or other sequence by touching an area of a screen which has been displayed.

Thus, in referring to FIG. 2 there is shown a typical telephone keyboard format which, as will be explained, is presented on the display 11 and which immediately becomes visible to the user. Thus, the user can essentially place a call by accessing the various display areas which will produce discrete signals generated by touching the various positions to enable a user to dial in a conventional manner. As indicated, FIG. 2 shows the conventional telephone keyboard of which we are all apprised of. This keyboard format, as will be explained, is generated by a microprocessor whereby when a subscriber goes off hook or desires to place a call, the keyboard format, as shown in FIG. 2, would be displayed.

Referring to FIG. 3 there is shown another replica of a telephone keyboard. It is immediately noted that the numbers, as for example compared to FIG. 2, are out of order or out of sequence. In any event, as will be further explained, the ability to generate a graphic keyboard format on a display, as electrophoretic display 11, enables one to easily exchange the various positions associated with a conventional keyboard. In this manner the display 11 can generate a random format indicative of a telephone keyboard where the user can view the format and dial a number in complete secrecy. This aspect can, therefore, enable high security dialing.

As one can ascertain, there are many people who are extremely competent in determining a number dialed by a person. These people can view a person making a call from a remote location and obtain the exact number dialed by viewing the sequence of dialing as implemented on a conventional telephone keyboard. In this manner, such persons have received unauthorized codes from watching a user dial in a secure number, such as a credit card number. These codes, for example, may also include MCI, Sprint or other access codes, as well as credit card numbers, to which an unauthorized user, by viewing the person dialing, may gain access.

Based on the generation of a display indicative of a keyboard, by means of electronic techniques, one can therefore randomly exchange the conventional key positions on the keyboard display as shown, for example, in FIG. 3. Thus, this will prevent unauthorized persons from ever knowing or determining the numbers dialed due to the random nature of the keyboard display, as generated by the circuitry to be described.

Thus, as one can further ascertain, FIG. 2 shows a completely conventional keyboard which is generated and displayed on the electrophoretic display 11, while FIG. 3 shows a random arrangement of another keyboard format which can also be utilized to generate dialing pulses indicative of a telephone call.

Apart from the above described mode of operation, another mode of operation will be described when viewing FIG. 5. It is well known that modern day telephone subsets have capacity for storage in memory of a plurality of telephone numbers. Most subsets can store 10 to 15 individual numbers or more, each of which may include eleven or more digits. These telephone numbers are associated with a directory that the user himself can formulate. In this manner modern telephone subsets enable a user to dial in and store a series of frequently called numbers. These numbers can then be dialed by merely pressing one button instead of dialing the entire sequence. In certain subsets the user would dial in, for example, two digits to access an 11 digit number. Such procedures and structures for implementing such subsets are well known. In fact, many of the circuits, as well as the techniques for implementing automatic dialing for a telephone subset, are available from many sources of manufacture. See, for example, U.S. Patent No. 4,011,414 issued on March 8, 1977, entitled "Automatic Dial System for a Subscriber Telephone" to W. D. Warren and assigned to Texas Instrument Incorporated of Dallas, Texas. This is one of many companies who supply such automatic dialing systems as well as complete integrated circuits for use in telephone subsets.

As will be explained, by utilizing a telephone subset with an electrophoretic display, as display 11, one can now substantially increase the number of stored telephone numbers as the consumer need no longer rely on memory or rely on a separate written directory for determining what numbers are stored in the system. As will be explained, the display, as shown in FIG. 5, is effectively capable of displaying a plurality of stored numbers, including the name of the individual or company associated with that number. In this manner a cursor (FIG. 5) is also presented whereby the cursor can move along the listing and when the subscriber moves the cursor to the number he desires to call he can now activate or access the call by pressing a further button, such as button 21 on the subset. When the cursor is aligned at a particular telephone number the activation of button 21 causes the telephone circuitry to automatically dial the number at the cursor position. This, therefore, enables one to store hundreds of telephone numbers in local memory and to display all numbers stored. Then, by means of the cursor, the subscriber can select any one of the numbers stored and thereby immediately commence dialing.

It is further indicated that the user can rapidly

scan the directory, or the telephone numbers as stored, by means of additional keys such as 17 and 18 and, hence, have rapid access to all numbers which are stored and displayed on the electrophoretic display 11 in order to initiate a dialing sequence or, for example, to look up or determine a certain number. Thus, as one can ascertain, the use of a high resolution, multiline display in conjunction with a subset will enable a user to access a large number of telephone numbers or other data. By use of the display each number will be associated with a particular company or individual to thereby enable such a user to commence a rapid dialing sequence without any further access to the telephone keyboard. The directory consists of multiple data pages where each page can be addressed by means of a mode key on the subset. Hence, a listing of hundreds of telephone numbers displayed as 50 or more at one time is accommodated.

Referring to FIG. 4, there is shown a detailed block diagram of the circuitry included within the telephone subset, such as subset 10 of FIG. 1. The telephone subset includes a controller or microprocessor 25. As one can ascertain, in today's technology there are many very powerful microprocessors which are commercially available. Certain microprocessors, for example, are capable of processing 32 bit words and are manufactured by many companies. See, for example, the microprocessor manufactured by Intel, Inc. as the 80386. The Motorola Corporation manufactures a microprocessor designated as the 68020 while the Zilog Company manufactures a microprocessor designated as the Z80000CPU. For further examples of suitable microprocessors, reference is made to a text entitled "32-bit Microprocessors" by H.J. Mitchell, published by the McGraw Hill Book Company (1986). In that text there is not only shown the structure of such microprocessors or controllers 25 but many of the applications associated with such devices.

The microprocessor or controller 25 is coupled to a mode selector module 26 which mode selector module interfaces with certain of the buttons or keys, as 15-20, associated with the telephone subset of FIG. 1. The mode selector 26, as will be further explained, can be implemented by programming the microprocessor in a well known manner.

In any event, the microprocessor 25 is typically associated with a random access memory or RAM 26 and a read only memory or ROM 27. Stored in the ROM are XY patterns indicative of a particular keyboard format, such as the keyboard shown in FIGS. 2 or 3 as well as others. The output of the ROM and RAM are coupled to a keyboard display module 30 which, essentially, controls an X decode and driver module 31 and a Y decode and driver module 32.

As indicated above, the display 11, which is an electrophoretic display, is addressed by means of an XY matrix arrangement. This is a common access technique for many memory and display devices. Thus, as one can ascertain, the X and Y decode and driver modules 31 and 32 are coupled to suitable terminals of the electrophoretic display 11. Hence, by the use of XY addressing, one can generate any type of display on the display 11 which will be visualized by the user.

As will be further explained, when the user implements a call he normally takes the handset 14 and places it in an off hook condition. This off hook condition is detected by means of an off hook detector 34 which, therefore, indicates to the controller or microprocessor 25 that a call is to be made. The controller 25 then accesses the suitable memory addresses of the ROM and RAM and displays the keyboard format shown in FIG. 2, for example. This, of course, is a conventional keyboard display. The keyboard format is, therefore, visually displayed to the user and, as indicated above, is associated with a position or pressure sensitive transparent overlay 12. Thus, the user then, by accessing the various areas of the display, can dial a number in a conventional manner. The exact dialing technique, and so on, will be explained subsequently.

In any event, if the user desires a high security mode, in which a random keyboard portrayal is to be provided, he may then activate access button 20 informing the mode selector to activate a random generator sequence indicative of module 33. In any event, one can generate a display, as for example shown in FIG. 3, by means of utilizing a random generator to randomly place the digits 0 to 9 in any location on the graphic keyboard display. However, it is also understood that a certain number of keyboard formats can be directly stored in ROM memory 27 and, hence, the user would have access, for example, to five different keyboards and by pressing key 20 any one of the different five keyboard would randomly appear. In any event, this will again allow the user to commence a dialing sequence. Such a random generator format is associated with ROM and RAM memory locations to enable the keyboard display 30 to present the format shown in FIG. 3 or any other format. The dialing sequence is decoded by the dial decoder 50 which is controlled by the microprocessor 25 according to the displayed graphic keyboard format.

Actually, the user will commence a dialing sequence which, essentially, would allow the telephone switching system to gain access to the dialed number. The system detects a ring back via the ring back detector 35 to thereby extinguish the display of the keyboard format to ready the subset display 11 for receiving data, if that is desired. In any event, if the user does not wish the display to be erased then the user can indicate this by pressing a save button also associated with the subset. There is also shown a data display buffer 60 which will be explained.

FIG. 6 shows a block diagram indicating the fur-

ther implementation of the various features, as described above. Essentially, the subset 10 may be associated with a pressure sensitive overlay 12 or any other type of touch or position overlay, as is well known in the art. The overlay 12 is coupled to a dial or TTMF generator 40 which includes dial decoder circuitry 50 of FIG. 1. The dial or TTMF generator 40 is a well known module and is available from many companies in integrated circuit form. The generator 40 converts the various switch positions associated with the display 11 to suitable frequencies or dial pulses to be transmitted over the telephone line 13 by means of conventional circuitry including the buffer or isolation amplifier 41. The dial or TTMF generator 40 includes a digit counter 42 coupled to the microprocessor 25 to determine each digit dialed for providing the proper timing. This is also well known. The telephone line is normally associated with a suitable buffer, which is available from many sources as well. The buffer 50 may contain storage and other suitable devices enabling one to transmit stored telephone numbers and thereby transmit the same over the conventional transmit or tip (TX) and receive or ring (RX) lines associated with the telephone line.

Also shown in FIG. 6 is the fact that the receive line RX is associated with a separate data buffer designated by reference numeral 60 and also shown in FIG. 1. The function of the data buffer 60 is to store incoming data and to direct the data to the RAM 26 or other memory sections of the microprocessor or controller 25. It is, of course, understood that such microprocessors can receive multiple inputs from various devices on real time input/output (I/O) buses. The microprocessor, as programmed, will then determine the nature of the data, as stored in data buffer 60, in order to properly activate the keyboard display 11 to enable the display of the proper data and to decode the data according to the incoming data format. As indicated, and can be ascertained from the above referenced U.S. Pat. No. 4,655,897, an electrophoretic display has extremely high resolution and such displays have been developed which are greater than 8-1/2 inch by 11 inch in area. See also a copending application entitled "ELECTROPHORETIC DISPLAY PANEL APPARATUS AND METHODS THEREFOR" filed on November 19, 1985, Ser. No. 799,458 for Frank J. DiSanto et al. and assigned to the assignee herein. Hence, the amount of data, as well as the resolution, can accommodate information of all sorts.

Thus, as can be ascertained from the above, the electrophoretic display, which has been described in U.S. Patent No. 4,655,897, is a high resolution display which does not require power for refreshing or storing data therein once the data is written. Essentially, by utilizing such a display, one can now generate a visual presentation of a telephone keyboard to enable a user to dial any desired number in conjunction with a position sensitive transparent overlay. It is, of course, understood that the keyboard format can be changed according to the desires of a user. Furthermore, by the use of such a high resolution display the telephone subset is now capable of storing a great many telephone numbers which can be displayed in terms of pages, for example, perhaps 10 or 50 telephone numbers on each page. The entire memory storage contents can be displayed and employed in conjunction with a movable cursor. In this manner, the subscriber can now see each telephone number stored in memory and also knows the entity to which the telephone number belongs. By moving the cursor he can now select the telephone number he wishes to access and by merely pressing one of the subset keys can dial that number without ever accessing the displayed keyboard mode. In this way the subscriber does not have to provide any individual or separate record of stored telephone numbers as is implemented in present day conventional telephone systems.

The entire mechanism for operating in the directory mode is again implemented by pressing a mode key associated with the mode selector 26. In this manner the mode selector 26, for example, upon the depression of subset switch 15, will again inform the microprocessor 25 that it is desired to display all telephone numbers stored in memory. The microprocessor 25 will then access the RAM or ROM 26 and 27 and cause the stored data, indicative of stored telephone numbers, to be presented to the keyboard display 30 which is also under control of the microprocessor. The keyboard display 30 generates the various alphanumeric characters as including a character generator which will convert the stored digital data into analog numerals, as is well known in the prior art, and hence display telephone numbers on the electrophoretic display 11.

At the same time a cursor is generated, which cursor can be moved along the directory display (FIG. 5) by means of additional subset buttons or keys. The cursor can be moved in an up or down direction as, for example, the cursor on a computer screen. Techniques for moving cursors to any location are well known. When the cursor is adjacent a desired number the user then merely presses a dial number key on the subset and the telephone number that the cursor is next to or aligned with, as shown in FIG. 5, is automatically dialed.

The above-noted techniques can be simply implemented by means of conventional programming and one skilled in the art should have absolutely no difficulty in displaying such stored numbers as, for example, according to the format depicted in FIG. 5. It is, of course, understood that many modern telephone sets have the ability to store numbers and the numbers stored, which for example may be 10 or more numbers, can be accessed and displayed directly on a single line LCD display or other type of display associated with present day telephone subsets.

The telephone subset of FIG. 1 also has an additional button or key which may be, for example, button 19. By pressing button 19 the telephone is now operated in a proprietary manner. For example, by depressing display button 19 the following sequence of events occur. The depression of button 19 informs the mode selector 26 to prompt the microprocessor 25 that a request is made to implement the generation of a keyboard display. The telephone user then dials in a four digit number, which is like a PIN number, as the same type of number as employed in conjunction with cash machines or credit card systems. The computer 25 compares the dialed in PIN number with a previously stored number and will indicate that the subscriber has access to confidential information contained in given memory locations of the read only memory 27. This information, for example, would present, on the display 11, all credit card numbers which belong to the possessor of the secret code. This will, therefore, enable the user to place calls to enable him to order various goods by means of the telephone subset 10. In any event, he is provided with a separate display contained in a separate memory location of all his credit card numbers.

The display also includes pertinent telephone numbers associated with those credit cards. For example, the number which he can call in regard to a missing or lost credit card, and so on. This data is easily stored in memory and, again, is accessible by means of the same techniques as described above.

Certain other features are immediately apparent and can be implemented with the exact circuitry shown in FIG. 4. For example, the above-noted system lends itself to furnishing a privacy phone lock. The operation would be as follows. With the handset 14 on hook, as shown in FIG. 1, the unit displays a simple array of characters which is not a keyboard format. These characters are stored in a reserved memory block and, essentially, are displayed on the electrophoretic display each time the handset is on hook. The electrophoretic display consumes no power once an array is written on the display. The user then must take the phone off hook and select a proper code via the characters displayed in the array to obtain a dial tone. Once the proper code is entered, a dial tone will be provided and the telephone keyboard display will be properly displayed. Otherwise no line connection can be made and one could not access the telephone line without having access to the code which may be implemented by means of the simple array of characters displayed on the display 11 when the hand set 14 is on hook.

It is, of course, understood that based on conventional techniques the telephone display 11 can also store and display a history of telephone usage, for example, the user code, the number dialed, the data, the time, the length of the call and so on. These techniques are, of course, incorporated in presently available commercial equipment, as well as being extensively described in the prior art.

Hence, it should be apparent to one skilled in the art that the provision of a high resolution display in conjunction with a telephone subset will provide many advantageous modes of operation which modes should be, as described above, understood by those skilled in the art.

Referring to FIG. 7 there is shown a detailed block diagram showing a telephone subset 10, as described above, employing an electrophoretic display panel 11 which is employed for data and graphics display. It is immediately noted that FIG. 7 retains the same reference numerals as previously described in conjunction with the above-noted figures. For example, in FIG. 7, there is shown the electrophoretic panel 11 which is coupled to X drive and Y drive circuits via panel control module designated as 31 and 32. The panel control is analogous to controls 31 and 32 of FIG. 4. As seen, the panel control is also coupled to a character generator 37 which essentially is coupled to the microprocessor 25 via a bidirectional address bus. Character generators for converting digital data into alphanumeric characters are also well known, as indicated in conjunction with FIG. 4, and can be implemented by the programming of the microprocessor 25.

Also shown is the overlay control designated by numeral 40. Essentially, as indicated, the overlay, which may be a pressure sensitive or other type of overlay, is coupled directly to a dial or DTMF generator 39 (FIG. 6). This again can be implemented by microprocessor programming. The overlay control 39 is also associated with additional circuitry for operating in different modes. As one can ascertain, the mode selector 26 will select and inform the microprocessor in regard to the mode of operation and interfaces with the microprocessor, as shown in FIG. 7, as controlled by means of the subset switches, as 15-20 of FIG. 1. Also shown is the PROM or ROM 27 and the RAM 26.

In any event, as indicated above, the entire subset normally interfaces with a conventional telephone line designated (PSTH) by means of a telephone interface 70, which is shown coupled to the handset 14 as part of subset 10. The telephone interface may include the remaining telephone circuitry, as well as various other registers and so on for data operation.

As seen, the entire unit is associated with a separate facsimile modem 66 which is one of many different types of available modems capable of receiving various types of facsimile transmissions, such as groups I, II, III. Such modems for converting facsimile transmissions into graphic data are well known and coupled to the fax modem 66 is a fax graphics controller 68 which converts the facsimile transmissions into suitable graphics to be applied to the panel control circuit 31 and then displayed directly on the panel

11 associated with the subset. Also shown is a modem control module 72 which is coupled to the fax modem 60 and which receives instructions from the control bus of the microprocessor 25 to enable proper operation. There is a modem selector 71 which essentially is a conventional component and which determines the exact nature of the facsimile transmission to allow proper decoding.

Hence, as shown in FIG. 7, and as above described, telephone apparatus can operate as a complete data subset whereby facsimile messages can be displayed directly on the display 11 and, for example, such a display can accommodate 500 or more lines of individual graphics, employing conventional facsimile modules and modems. In this manner the entire subset, based on its use in conjunction with a high resolution display, has great capabilities and versatilities as should be apparent to those skilled in the art when reviewing the above-noted specification.

Claims

1. A telephone subset apparatus for use in providing high quality data displays, said apparatus being of the type comprising: a telephone subset (10) including a housing having a telephone handset (14) coupled thereto, a high resolution display panel means (11) mounted on a top surface of said housing and capable of being accessed by an addressing means (31,32) to display graphic data in a plurality of lines and microprocessor means (25) coupled to said display panel and operative to cause said panel to provide a graphics display according to said addressing means, characterised by:

   means (33) associated with said microprocessor means operative to cause said display panel to provide a graphic representation of a telephone keyboard arrangement which is a substantially random keyboard presentation; and

   position sensitive means (12) coupled to said panel and operative when accessed to produce a telephone number output signal as dialed by a user employing said random presentation as a guide for selecting said number.

2. Apparatus according to claim 1, wherein said display panel means (11) includes an electrophoretic display.

3. Apparatus according to either preceding claim 1 or 2, wherein said microprocessor means (25) includes an X decoder means (31) coupled to said display (11) and addressed by said microprocessor means to generate X data for said display and a Y decoder means (32) coupled to said display and addressed by said microprocessor to generate Y data for said display.

4. Apparatus according to any one of the preceding claims 1 to 3, wherein said microprocessor means (25) includes first storage means (26,27) coupled thereto and operative to store data indicative of various graphic keyboard presentations to enable a user to dial a telephone number based on any one of a different number of said keyboard presentations.

5. Apparatus according to claim 4, further including means (35) coupled to said handset (14) and operative to provide a control signal when said handset is lifted off hook.

6. Apparatus according to claim 5, wherein said microprocessor means (25) is responsive to said control signal to generate any one of said various graphic keyboard presentations as stored.

7. Apparatus according to any one of the preceding claims 1 to 6, further including interface means (70) coupled to said display panel means (11) for coupling said display panel means to a telephone line (13).

8. Apparatus according to claim 7, wherein said interface means further includes a dialing generator (40) coupled to said position sensitive means (39) and operative to provide telephone dialing signals to said telephone line (13).

9. Apparatus according to any one of the preceding claims 1 to 8, further including a plurality of actuatable keys (15,19,20) mounted on the top surface of said housing and coupled to a mode selector means (26) included in said microprocessor means (25) for operating said microprocessor means in any one of a plurality of modes according to the selection of an associated key for said mode.

10. Apparatus according to claim 9, further including second storage means (26,27) operative to store therein a plurality of telephone numbers indicative of called parties, said second storage means accessed by a first one (17 or 18) of said mode keys to cause said display to display a first plurality of stored numbers simultaneously thereon, and cursor means associated with said display and operative to movably align adjacent each number as displayed under control of said user by at least a second one of said keys (21) to enable a user to select any one of said displayed numbers, and means coupled to a third one of said keys to cause the number aligned with said cursor to be dialed.

11. Apparatus according to claim 10, wherein said plurality of numbers as stored are displayed in consecutive display presentations to thereby store a large directory of telephone numbers which are displayed in groups of numbers on a page-to-page basis.

12. Apparatus according to any one of the preceding claims 9 to 11, further including third storage means (27) coupled to said microprocessor means (25) and operative to store therein a plurality of credit card numbers associated with a user of said subset and accessible by means of a fourth subset mode key to provide said user with a display indicative of said credit card numbers.

13. Apparatus according to claim 12, further including means (19,26) coupled to said display and operative when said handset is on hook to provide an array of separate characters wherein said subscriber can access said third storage means (26,27) only by first selecting a given set of characters in said displayed array.

14. Apparatus according to claim 4, wherein said first storage means includes a ROM (27) and a RAM (26).

15. Apparatus according to any one of the preceding claims 1 to 14, further including means coupled to said display means for generating a display of telephone usage.

16. Apparatus according to claim 7 wherein said interface means includes means (66,68) for receiving facsimile transmissions from said telephone line (13) and for converting said transmissions to graphic data for display by said display panel (11).

17. Apparatus according to claim 16, further including a data buffer means (60) coupled to said telephone line (13) for storing received data prior to processing the same said data buffer means coupled to said microprocessor means (25).

18. Apparatus according to claim 17, further including ring-back detector means (35) coupled to said telephone line and operative to provide a control signal when a connection is made between said subset and a called party by detecting ring back, with said detector coupled to said microprocessor means (25) to enable said microprocessor to ready said subset (10) for the receipt of data from said caller party.

19. Apparatus according to any one of the preceding claims 1 to 18, wherein said position sensitive means (12) includes a pressure sensitive overlay which overlay is positioned over said display (11) and provides position sensitive output signals according to the area of said display contacted by a user exerting pressure thereat.

20. Apparatus according to any one of the preceding claims 1 to 19, wherein said microprocessor means (25) includes character generator means (37) operative to convert digital data as stored to alpha numeric character data for addressing said X-Y display.

21. Apparatus according to claim 1, wherein said means (33) associated with said microprocessor means comprise a random number generator.

Patentansprüche

1. Eine Telefonbasisteilvorrichtung zur Verwendung, um hochqualitative Datenanzeigen zur Verfügung zu stellen, wobei die Vorrichtung von dem Typ ist, der aus einem Telefonbasisteil (10), das ein Gehäuse mit einem daran angeschlossenen Telefonhörer (14) enthält, einer hochauflösenden Anzeigetafeleinrichtung (11), die an einer oberen Oberfläche des Gehäuses befestigt ist und auf die durch eine Adressiereinrichtung (31, 32) zugegriffen werden kann, um grafische Daten in einer Mehrzahl von Linien anzuzeigen, und einer Mikroprozessoreinrichtung (25), die an die Anzeigetafel angeschlossen ist und die die Tafel veranlassen kann, eine grafische Anzeige gemäß der Adressiereinrichtung zur Verfügung zu stellen, besteht,
gekennzeichnet durch,
eine mit der Mikroprozessoreinrichtung verbundene Einrichtung (33), die die Anzeigetafel veranlassen kann, eine grafische Darstellung einer Telefontastaturanordnung zur Verfügung zu stellen, die eine im wesentlichen willkürliche Tastaturdarstellung ist; und eine positionssensitive Einrichtung (12), die an die Tafel angeschlossen ist und die in Betrieb ist, wenn auf sie zugegriffen wird, um ein Telefonnummerausgangssignal, so wie es von einem Benutzer gewählt ist, der die willkürliche Darstellung als eine Führung zur Auswahl der Nummer anwendet, zu erzeugen.

2. Vorrichtung nach Anspruch 1, worin die Anzeigetafeleinrichtung (11) eine elektrophoretische Anzeige enthält.

3. Vorrichtung nach einem der voranstehenden Ansprüche 1 oder 2, worin die Mikroprozessoreinrichtung (25) eine X-Decodereinrichtung (31), die an die Anzeige (11) angeschlossen ist und die

von der Mikroprozessoreinrichtung angesteuert wird, um X-Daten für die Anzeige zu erzeugen, und eine Y-Decodereinrichtung (32), die an die Anzeige angeschlossen ist und die von dem Mikroprozessor angesteuert wird, um Y-Daten für die Anzeige zu erzeugen, enthält.

4. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 3, worin die Mikroprozessoreinrichtung (25) eine erste Speichereinrichtung (26, 27) enthält, die daran angeschlossen ist und die Daten speichern kann, die für verschiedene grafische Tastaturdarstellungen bezeichnend sind, um einem Benutzer zu ermöglichen, basierend auf irgendeiner von einer unterschiedlichen Anzahl der Tastaturdarstellungen eine Telefonnummer zu wählen.

5. Vorrichtung nach Anspruch 4, die desweiteren eine Einrichtung (35) enthält, die an den Hörer (14) angeschlossen ist und die ein Steuersignal zur Verfügung stellen kann, wenn der Hörer abgenommen wird.

6. Vorrichtung nach Anspruch 5, worin die Mikroprozessoreinrichtung (25) auf das Steuersignal anspricht, um irgendeine der verschiedenen grafischen Tastaturdarstellungen, so wie sie gespeichert sind, zu erzeugen.

7. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 6, die desweiteren eine Schnittstelleneinrichtung (70) enthält, die an die Anzeigetafeleinrichtung (11) angeschlossen ist, um die Anzeigetafeleinrichtung an eine Telefonleitung (13) anzuschließen.

8. Vorrichtung gemäß Anspruch 7, worin die Schnittstelleneinrichtung desweiteren einen Wählgenerator (40) enthält, der an die positionssensitive Einrichtung (39) angeschlossen ist und der der Telefonleitung (13) Telefonwählzeichen zur Verfügung stellen kann.

9. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 8, die desweiteren eine Mehrzahl auslösbarer Tasten (15, 19, 20) enthält, die an der oberen Oberfläche des Gehäuses befestigt sind und die an einer in der Mikroprozessoreinrichtung (25) enthaltenen Modusauswahleinrichtung (26) enthalten sind, um die Mikroprozessoreinrichtung in irgendeiner aus einer Mehrzahl von Modi zu betreiben, gemäß der Auswahl einer zugehörigen Taste für diesen Modus.

10. Vorrichtung nach Anspruch 9, die desweiteren eine zweite Speichereinrichtung (26, 27), die darin eine Mehrzahl von Telefonnummern, welche angerufene Parteien bezeichnen, speichern kann, wobei auf die zweite Speichereinrichtung durch eine erste (17 oder 18) der Modustasten zugegriffen werden kann, um die Anzeige zu veranlassen, eine erste Mehrzahl gespeicherter Nummern gleichzeitig darauf anzuzeigen, und eine Cursoreinrichtung, die mit der Anzeige verbunden ist und die durch Steuerung des Benutzers mittels mindestens einer zweiten der Tasten (21) an jede der dargestellten Nummern angrenzend beweglich ausgerichtet werden kann, um einem Benutzer zu ermöglichen, irgendeine der angezeigten Nummern auszuwählen, und eine Einrichtung, die an eine dritte der Tasten angeschlossen ist, um zu veranlassen, daß die mit dem Cursor ausgerichtete Nummer gewählt wird, enthält.

11. Vorrichtung nach Anspruch 10, worin die Mehrzahl von Nummern, so wie sie gespeichert sind, in aufeinanderfolgenden Anzeigedarstellungen angezeigt werden, um dadurch ein großes Verzeichnis von Telefonnummern zu speichern, die in Nummerngruppen seitenweise angezeigt werden.

12. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 9 bis 11, die desweiteren eine dritte Speichereinrichtung (27) enthält, die an die Mikroprozessoreinrichtung (25) angeschlossen ist und die eine Mehrzahl von einem Benutzer des Basisteils zugehörigen Kreditkartennummern einspeichern kann und die mittels einer vierten Basisteilmodustaste zugänglich ist, um dem Benutzer eine Anzeige zur Verfügung zu stellen, die die Kreditkartennummern bezeichnet.

13. Vorrichtung nach Anspruch 12, die desweiteren eine Einrichtung (19, 26) enthält, die an die Anzeige angeschlossen ist und die in Betrieb ist, wenn der Hörer aufgelegt ist, um eine Aufstellung separater Zeichen zur Verfügung zu stellen, wobei der Teilnehmer auf die dritte Speichereinrichtung (26, 27) nur zugreifen kann, indem er zuerst einen gegebenen Zeichensatz aus der angezeigten Aufstellung auswählt.

14. Vorrichtung nach Anspruch 4, worin die erste Speichereinrichtung ein ROM (27) und ein RAM (26) enthält.

15. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 14, die desweiteren eine Einrichtung enthält, die an die Anzeigeneinrichtung angeschlossen ist, um eine Telefonbenutzungsanzeige zu erzeugen.

16. Vorrichtung nach Anspruch 7, worin die Schnitt-

stelleneinrichtung zum Empfängen von Faxsendungen aus der Telefonleitung (13) und zur Umwandlung der Sendungen in grafische Daten für die Anzeige durch die Anzeigentafel (11) eine Einrichtung (66, 68) enthält.

17. Vorrichtung nach Anspruch 16, die desweiteren eine Datenpuffereinrichtung (60) enthält, die an die Telefonleitung (13) zur Speicherung empfängener Daten angeschlossen ist, bevor dieselben verarbeitet werden, wobei die Datenspeichereinrichtung an die Mikroprozessoreinrichtung (25) angeschlossen ist.

18. Vorrichtung nach Anspruch 17, die desweiteren eine Rückrufdetektoreinrichtung (35) enthält, die an die Telefonleitung angeschlossen ist und die durch Ermittlung eines Rückrufs ein Steuersignal zur Verfügung stellen kann, wenn eine Verbindung zwischen dem Basisteil und einer angerufenen Partei hergestellt ist, wobei der Detektor an die Mikroprozessoreinrichtung (25) angeschlossen ist, um dem Mikroprozessor zu ermöglichen, das Basisteil (10) für den Empfang von Daten der anrufenden Partei bereitzustellen.

19. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 18, worin die positionssensitive Einrichtung (12) eine drucksensitive Auflage beinhaltet, die über der Anzeige (11) positioniert ist und positionssensitive Ausgangssignale entsprechend den Anzeigenbereichen, die durch einen darauf Druck ausübenden Benutzer berührt werden, zur Verfügung stellt.

20. Vorrichtung nach irgendeinem der voranstehenden Ansprüche 1 bis 19, worin die Mikroprozessoreinrichtung (25) eine Ziffernerzeugungseinrichtung (37) enthält, die digitale Daten, so wie sie gespeichert sind, in alphanumerische Datenzeichen für die Adressierung der X-Y-Anzeige umwandeln kann.

21. Vorrichtung nach Anspruch 1, worin die Einrichtung (33), die mit der Mikroprozessoreinrichtung verbunden ist, einen Zufallsnummerngenerator umfaßt.

Revendications

1. Poste téléphonique d'abonné à utiliser en fournissant des affichages de données de haute qualité, ledit poste étant du type comprenant : un poste téléphonique (10) comprenant un boitier comportant un combiné téléphonique (14) qui est couplé au boitier, un moyen de panneau d'affichage de résolution élevée (11) monté sur une surface supérieure dudit boitier et d'accès possible à l'aide d'un moyen d'adressage (31, 32) pour afficher des données graphiques suivant une pluralité de lignes et un moyen de microprocesseur (25) couplé audit panneau d'affichage et opérationnel pour entrainer ledit panneau à fournir un affichage d'informations graphiques selon ledit moyen d'adressage, caractérisé par :

un moyen (33) associé audit moyen de microprocesseur opérationnel pour entrainer ledit panneau d'affichage à fournir une représentation graphique d'un agencement de clavier téléphonique qui est une présentation de clavier pratiquement aléatoire ; et

un moyen sensible une position (12) couplé audit panneau et opérationnel lorsqu'il est sollicité pour produire un signal de sortie de numéro téléphonique tel que composé par un utilisateur employant ladite présentation aléatoire comme guide pour sélectionner ledit numéro.

2. Poste selon la revendication 1, dans lequel ledit moyen de panneau d'affichage (11) comporte un afficheur électrophorétique.

3. Poste selon l'une ou l'autre des revendications précédentes 1 ou 2, dans lequel ledit moyen de microprocesseur (25) comporte un moyen décodeur en X (31) couplé audit afficheur (11) et adressé par ledit moyen de microprocesseur pour créer des données en X destinées audit afficheur et un moyen décodeur en Y (32) couplé audit afficheur et adressé par ledit microprocesseur pour créer des données en Y destinées audit afficheur.

4. Poste selon l'une quelconque des revendications précédentes 1 à 3, dans lequel ledit moyen de microprocesseur (25) comprend un premier moyen de stockage (26,27) qui lui est couplé et opérationnel pour stocker des données indicatrices des différentes présentations graphiques des claviers pour permettre à un utilisateur de composer un numéro téléphonique sur la base de l'un quelconque des différents numéros desdites présentations de claviers.

5. Poste selon la revendication 4, comprenant de plus un moyen (35) couplé audit combiné (14) et opérationnel pour fournir un signal de commande lorsque ledit combiné est décroché.

6. Poste selon la revendication 5, dans lequel ledit moyen de microprocesseur (25) est sensible audit signal de commande pour créer l'une quelconque desdites différentes présentations de clavier graphique telles que stockées.

7. Poste selon l'une quelconque des revendications précédentes 1 à 6, comprenant, de plus, un moyen d'interface (70) couplé audit moyen de panneau d'affichage (11) pour coupler ledit moyen de panneau d'affichage à une ligne téléphonique (13).

8. Poste selon la revendication 7 dans lequel ledit moyen d'interface comporte de plus un générateur de numérotation (40) couplé audit moyen sensible à une position (39) et opérationnel pour fournir des signaux de numérotation téléphonique à ladite ligne téléphonique (13).

9. Poste selon l'une quelconque des revendications précédentes 1 à 8, comprenant de plus une pluralité de touches actionnables (15,19,20) montées sur la surface supérieure dudit boitier et couplées à un moyen sélecteur de modes (26) inclus dans ledit moyen de microprocesseur (25) pour faire fonctionner ledit moyen de microprocesseur selon l'un quelconque d'une pluralité de modes suivant la sélection d'une touche associée destinée audit mode.

10. Poste selon la revendication 9, comprenant de plus un second moyen de stockage (26,27) opérationnel pour y stocker une pluralité de numéros téléphoniques indicateurs des correspondants appelés, ledit second moyen de stockage étant accessible à l'aide d'une première (17 ou 18) desdites touches de mode pour entrainer ledit afficheur à afficher simultanément une première pluralité de numéros stockés et un moyen de curseur associé audit afficheur et opérationnel pour s'aligner de façon déplaçable à côté de chaque numéro tel qu'affiché sous un contrôle dudit utilisateur à l'aide d'au moins une seconde desdites touches (21) afin de permettre à un utilisateur de sélectionner l'un quelconque desdits numéros affichés et un moyen couplé à une troisième desdites touches pour provoquer la composition du numéro aligné avec ledit curseur.

11. Poste selon la revendication 10 dans lequel ladite pluralité de numéros tels que stockés est affichée dans des présentations d'affichage consécutives pour stocker ainsi un grand répertoire de numéros téléphoniques qui sont affichés par groupe de numéros sur une base de page par page.

12. Poste selon l'une quelconque des revendications précédentes 9 à 11, comprenant de plus un troisième moyen de stockage (27) couplé audit moyen de microprocesseur (25) et opérationnel pour y stocker une pluralité de numéros de cartes de crédit associés à un utilisateur dudit poste téléphonique et accessible à l'aide d'une quatrième touche de mode de fonctionnement du poste pour fournir audit utilisateur un affichage indicateur desdits numéros de cartes de crédit.

13. Poste selon la revendication 12, comprenant de plus un moyen (19, 26) couplé audit afficheur et opérationnel lorsque ledit combiné est raccroché, pour fournir un réseau de caractères séparé dans lequel ledit abonné peut accéder audit troisième moyen de stockage (26,27) seulement en sélectionnant d'abord un ensemble donné de caractères dudit tableau affiché.

14. Poste selon la revendication 4, dans lequel ledit premier moyen de stockage comprend une mémoire ROM (27) et une mémoire RAM (26).

15. Poste selon l'une quelconque des revendications précédentes 1 à 14, comprenant de plus un moyen couplé audit moyen d'affichage pour créer un afficheur d'usage téléphonique .

16. Poste selon la revendication 7 dans lequel ledit moyen d'interface comprend un moyen (66, 68) pour recevoir des transmissions de fac-similé à partir de ladite ligne téléphonique (13) et pour convertir lesdites transmissions en données graphiques destinées à être affichées par ledit panneau d'affichage (11).

17. Poste selon la revendication 16, comprenant de plus un moyen de mémoire tampon de données (60) couplé à ladite ligne téléphonique (13) pour stocker les données reçues avant de les traiter, ledit moyen de mémoire tampon de données étant couplé audit moyen de microprocesseur (25).

18. Poste selon la revendication 17, comprenant de plus un moyen détecteur de rappel automatique (35) couplé à ladite ligne téléphonique et opérationnel pour fournir un signal de commande lorsqu'une connexion est réalisée entre ledit poste d'abonné et un correspondant appelé par une détection de rappel automatique , ledit détecteur étant couplé audit moyen de microprocesseur (25) pour permettre audit microprocesseur de préparer ledit poste (10) à recevoir des données venant dudit correspondant appelant.

19. Poste selon l'une quelconque des revendications précédentes 1 à 18, dans lequel ledit moyen sensible en position (12) comporte une couche de recouvrement sensible à la pression, laquelle couche de recouvrement est située sur ledit afficheur (11) et fournit des signaux de sortie sensibles à une position suivant les zones dudit afficheur en contact avec un utilisateur exerçant une pression

à ce niveau .

20. Poste selon l'une quelconque des revendications précédentes 1 à 19, dans lequel ledit moyen de microprocesseur (16,25) inclut un moyen générateur de caractères (37) opérationnel pour convertir des données numériques telles que stockées en données de caractère alpha numérique destinées à un adressage dudit afficheur X-Y.

21. Poste selon la revendication 1, dans lequel ledit moyen (33) associé audit moyen de microprocesseur comprend un générateur de numéros aléatoires.

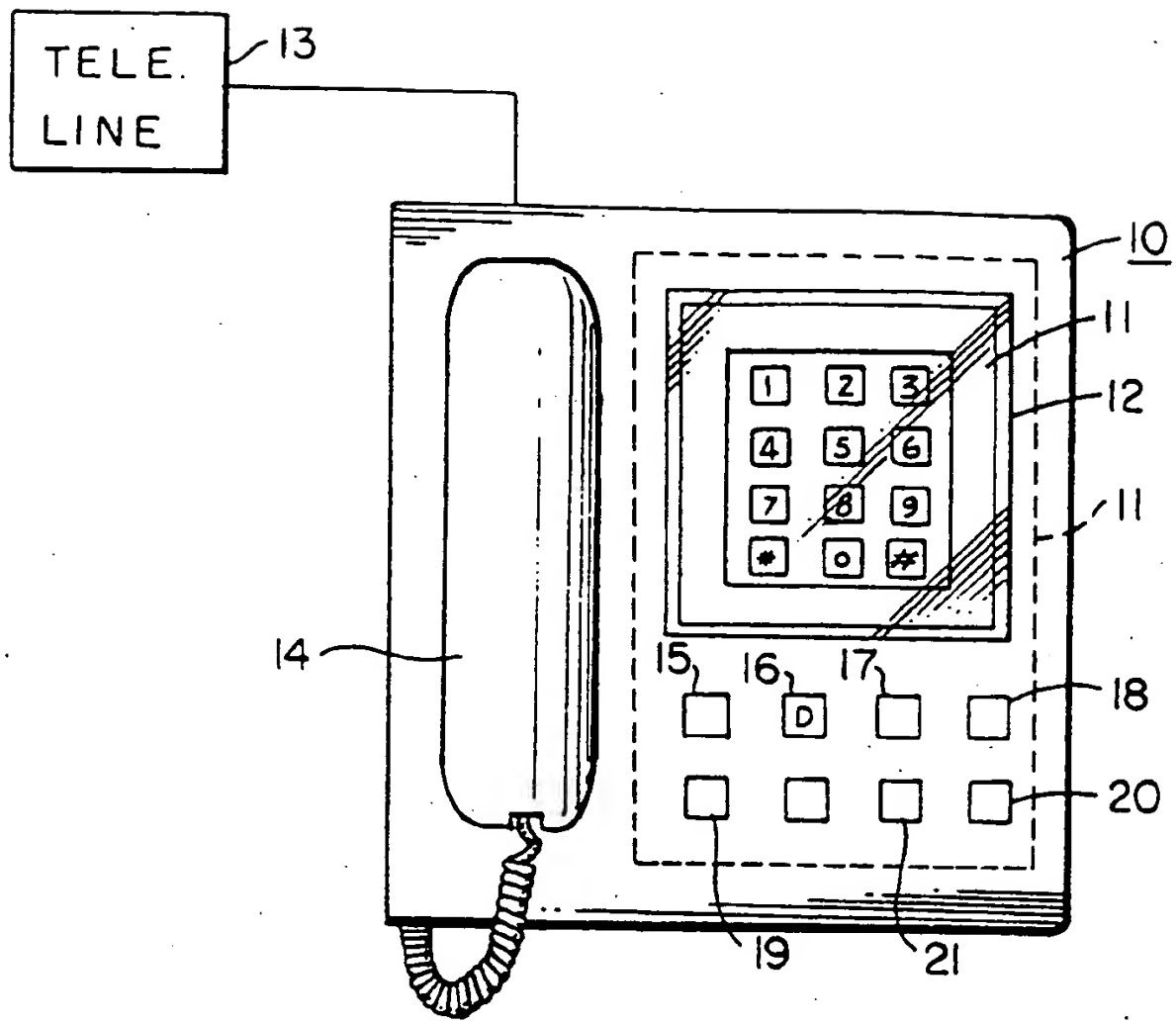

FIG. 1

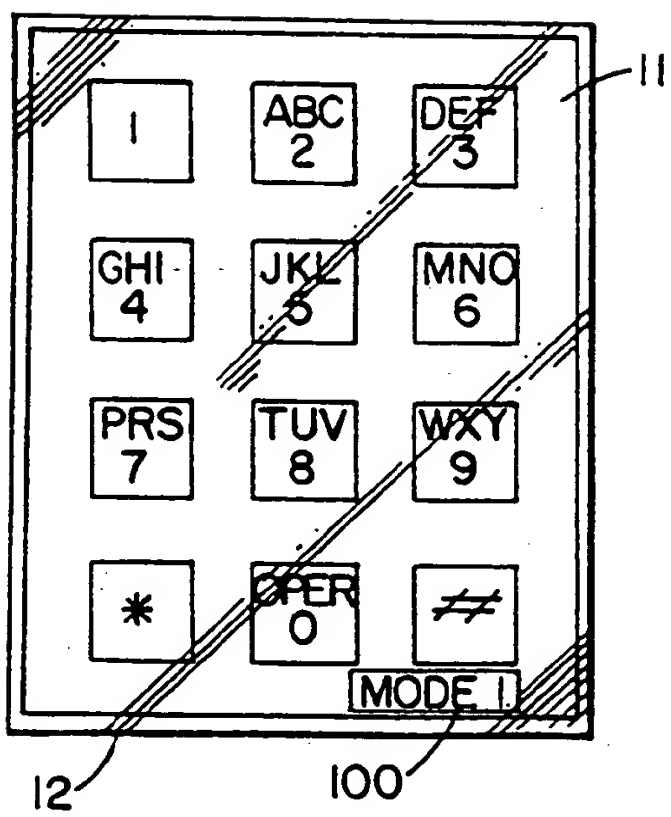

FIG. 2

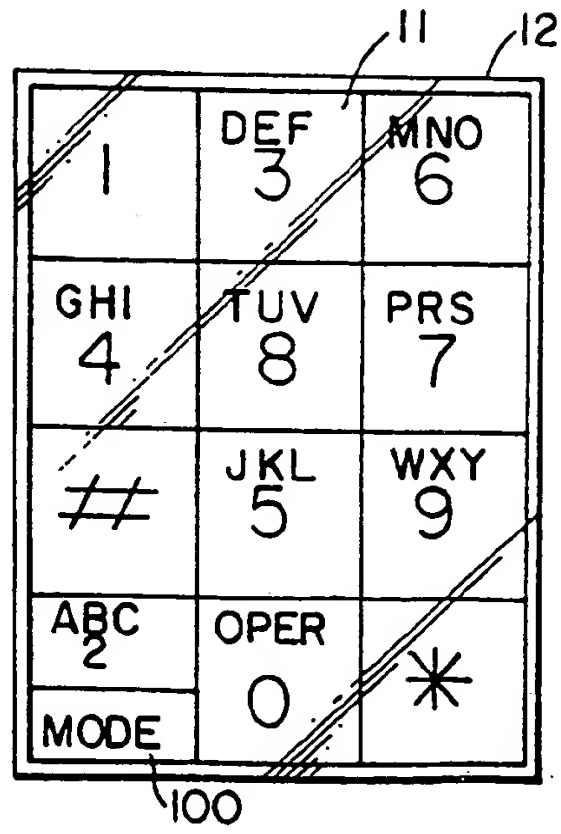

FIG. 3

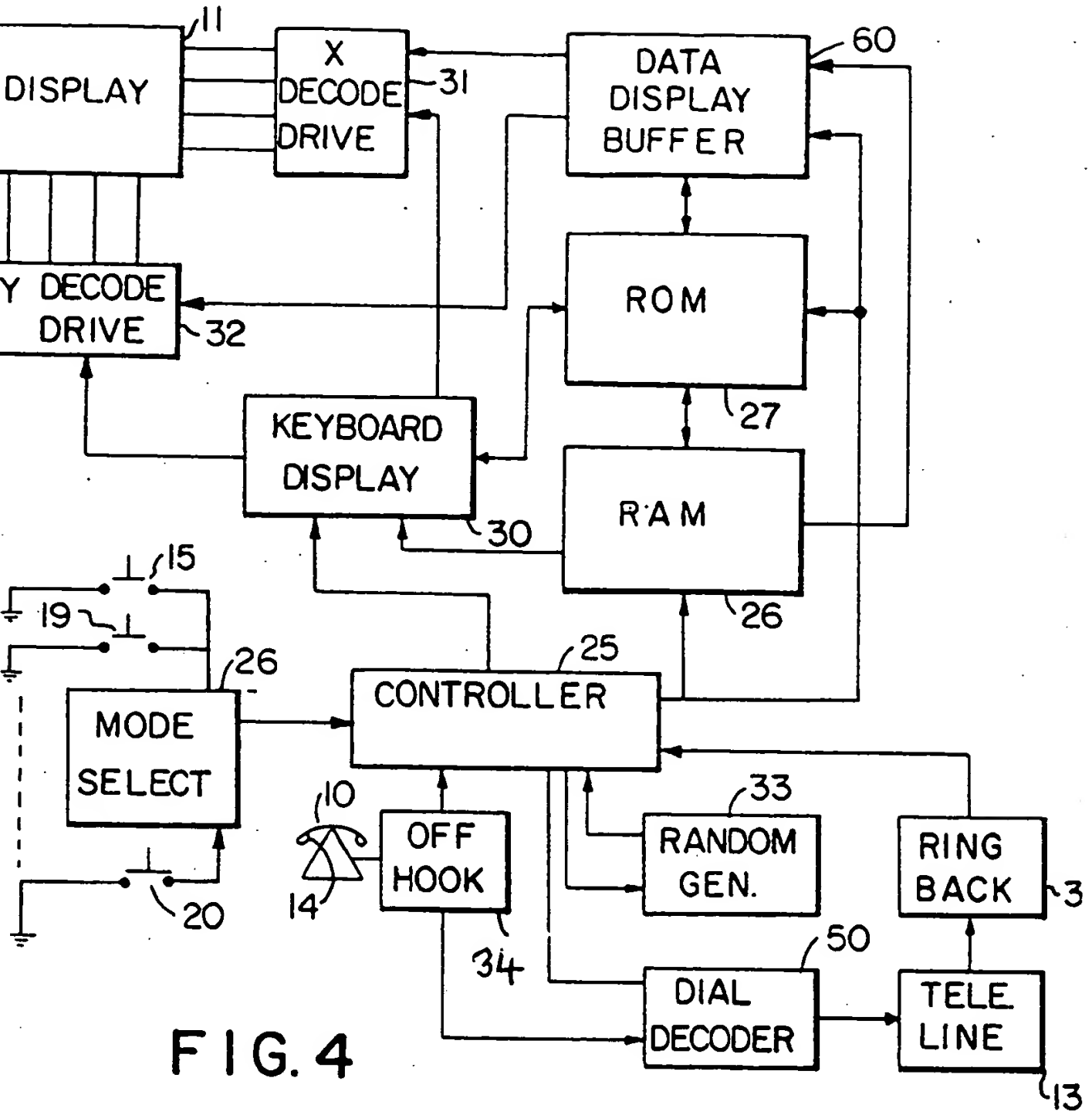
DISPLAY
11
X DECODE DRIVE
31
DATA DISPLAY BUFFER
60
Y DECODE DRIVE
32
ROM
27
KEYBOARD DISPLAY
30
RAM
26
15
19
26
MODE SELECT
20
25
CONTROLLER
10
14
OFF HOOK
34
33
RANDOM GEN.
RING BACK
3
50
DIAL DECODER
TELE LINE
13

FIG. 4

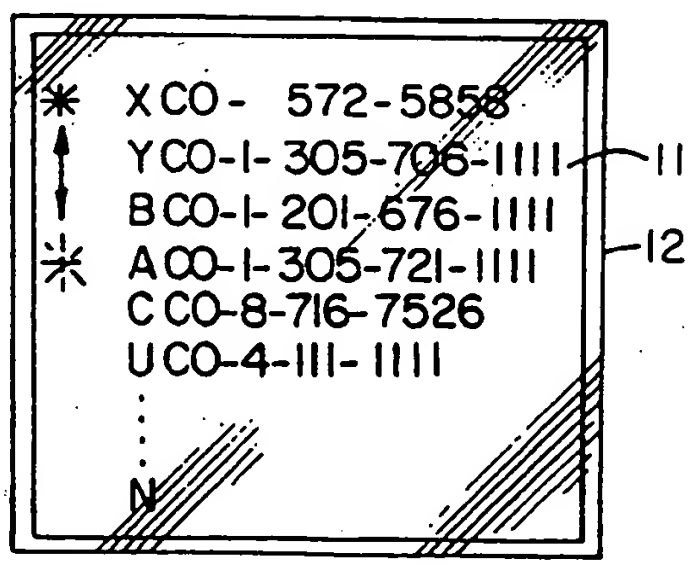
XCO- 572-5858
YCO-1-305-706-1111
BCO-1-201-676-1111
ACO-1-305-721-1111
CCO-8-716-7526
UCO-4-111-1111
N
11
12

FIG. 5

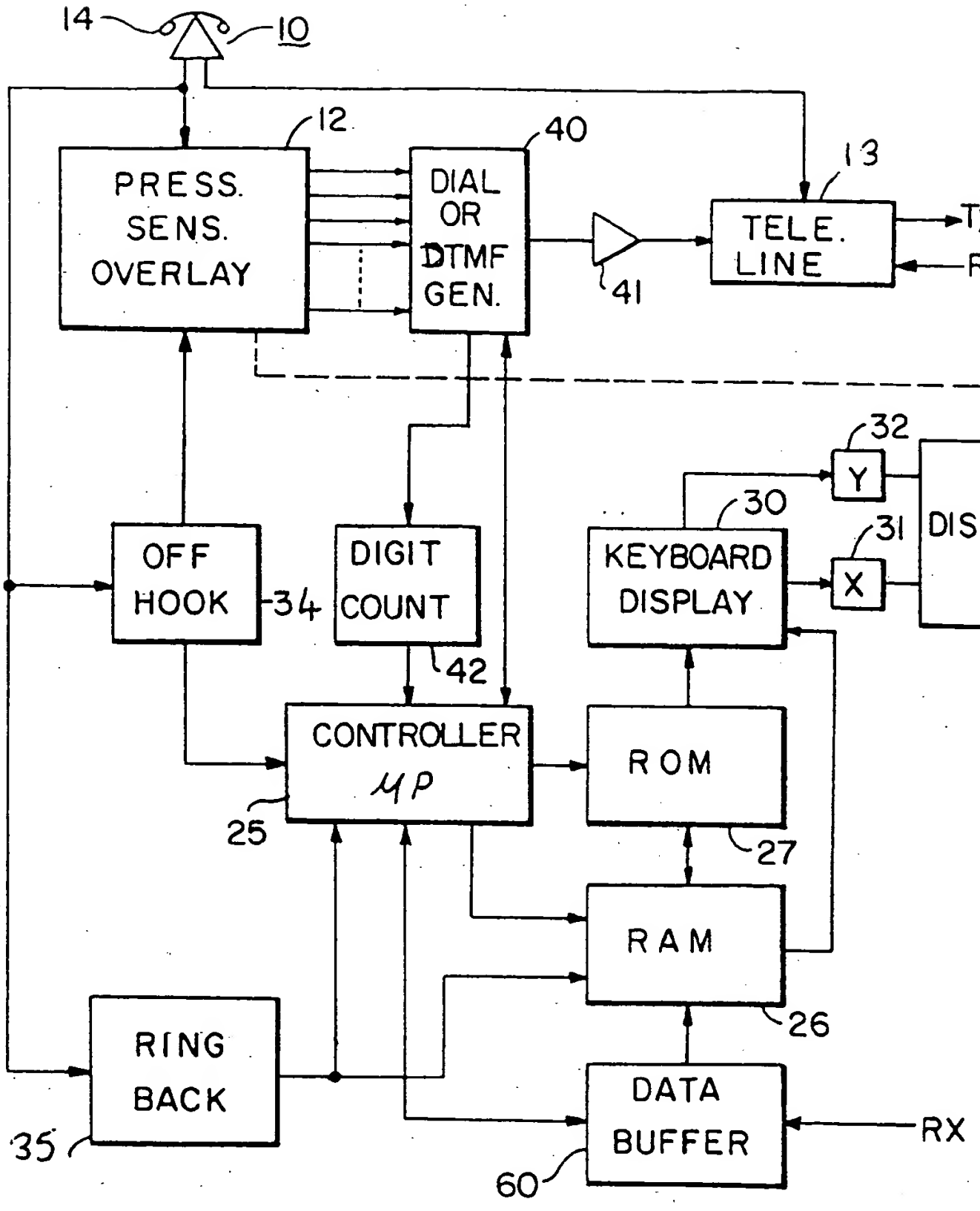
14
10
12
40
13
PRESS.
SENS.
OVERLAY
DIAL
OR
DTMF
GEN.
41
TELE.
LINE
TX
RX
11
32
Y
30
31
DISPLAY
OFF
HOOK
34
DIGIT
COUNT
KEYBOARD
DISPLAY
X
42
CONTROLLER
μP
ROM
25
27
RAM
26
RING
BACK
35
DATA
BUFFER
RX
60

FIG. 6

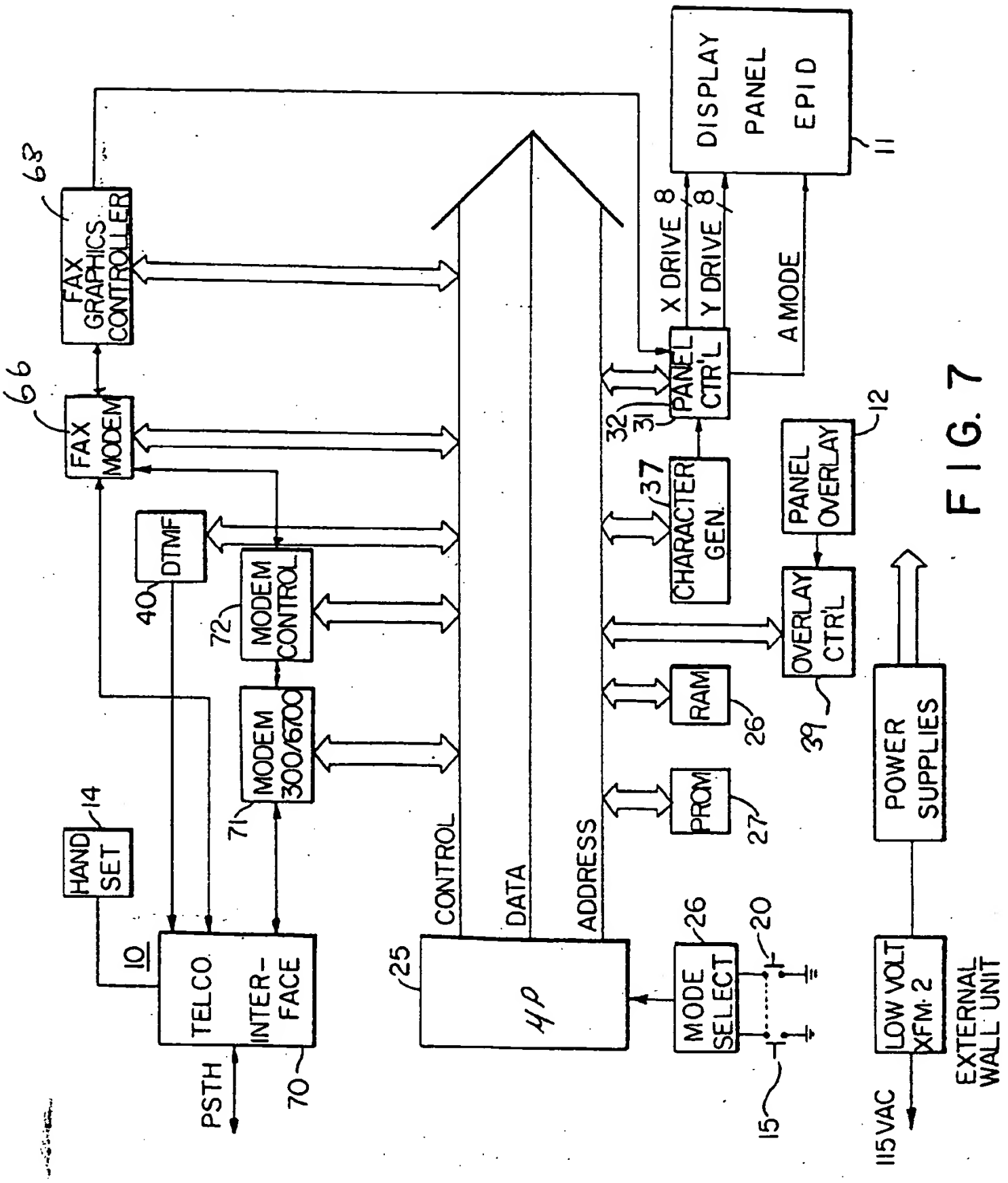
DISPLAY PANEL EPI D
11
X DRIVE 8
Y DRIVE 8
A MODE
PANEL CTR'L
32
31
63
FAX GRAPHICS CONTROLLER
66
FAX MODEM
DTMF
40
MODEM CONTROL
72
MODEM 300/6700
71
HAND SET
14
10
TELCO INTER-FACE
PSTH
70
CONTROL
DATA
ADDRESS
25
μP
CHARACTER GEN.
37
PANEL OVERLAY
12
OVERLAY CTR'L
39
RAM
26
PROM
27
MODE SELECT
26
20
15
POWER SUPPLIES
LOW VOLT XFM. 2
115 VAC
EXTERNAL WALL UNIT

FIG. 7

B10

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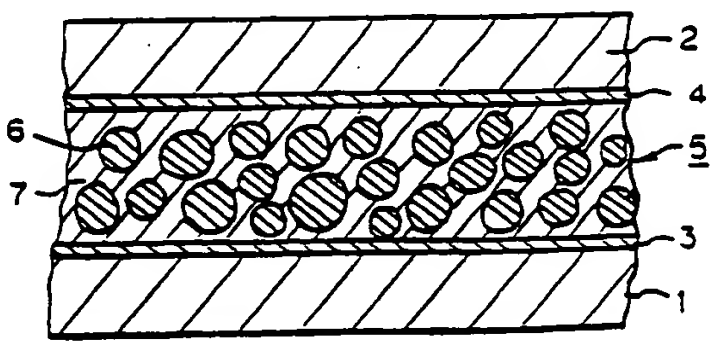
(54) Liquid crystal display panel.

(57) A liquid crystal display panel for displaying colored images while controlling a transmission of light therethrough, comprises a first transparent base, a first transparent electrode arranged on the first base, a second transparent base, a second transparent electrode arranged on the second base and facing the first electrode and a liquid crystal layer interposed between the picture element electrode and the scanning electrode and formed by a polymer dispersed liquid crystal material comprising (a) a polymeric medium, (b) a liquid crystal material surrounded by surface means or a matrix consisting of the polymeric medium, and (c) a coloring material contained in the polymeric medium and/or the liquid crystal material, the polymeric medium optionally further comprising a visible ray-absorbing black material and the liquid crystal material optionally comprising a pleochroic dye.

Fig. 1



EP 0 443 571 A2

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display panel. More particularly, the present invention relates to a liquid crystal display panel for colored images, in which a polymer dispersed liquid crystal material is used and which is able to control a light transmission therethrough.

2. Description of the Related Arts

Recently, a new liquid crystal material, i.e., a polymer dispersed liquid crystal material, has been developed, and this new liquid crystal material is widely utilized for a film-shaped light shutter having a large area or for a large area display material.

The polymer dispersed liquid crystal material is disclosed in PCT International Publication No. 83/01016, U.S. Patent No. 4,435,047 and "Electronic Parts and Materials" No. 12, 1987, pages 67 to 70. In the polymer dispersed type liquid crystal material, a liquid crystal material having a positive dielectric anisotropy is surrounded by a transparent surface means or matrix for affecting the natural structure of the liquid crystal material, to induce a distorted alignment thereof in the absence of an electric field and thus reduce the optical transmission. The liquid crystal material is responsive to the presence of an electric field, to increase the amount of optical transmission.

When the polymer dispersed liquid crystal material is prepared by using a liquid crystal material having a positive dielectric anisotropy and an ordinary refractive index substantially equal to the refractive index of the polymer, and a layer of the polymer dispersed liquid crystal material is interposed between a pair of electrode bases, the resultant liquid crystal display device can scatter the light in the absence of an electric field and can allow the light to transmit therethrough in the presence of an electric field.

The polymer dispersed liquid crystal material includes (1) Nematic Curvilinear Aligned Phase (NCAP) type liquid crystal materials in which liquid crystals are dispersed in the form of fine spheres independently from each other in a matrix consisting of a water-soluble polymeric material, as disclosed in the above-mentioned PCT international publication; (2) liquid crystal materials in which liquid crystals are dispersed and contained in a thermoplastic resin latex matrix, as disclosed in Japanese Unexamined Patent Publication No. 60-252,687; (3) liquid crystal materials in which liquid crystals are dispersed in the form of fine particles in an epoxy resin matrix, as disclosed in PCT Japanese Publication No. 61-502,128; and (4) liquid crystal materials in which liquid crystals are present in the form of at least one continuous network extending in a polymeric matrix, and which is prepared by a solvent cast method, as disclosed in Polymer Preprints, Japan, Vol. 37, No. 8, 2450 (1988), and Japanese Unexamined Patent Publication No. 1-198,725.

Where the conventional polymer dispersed liquid crystal material is used for a liquid crystal display panel for colored images, usually the display panel must be equipped with a color filter. In this conventional colored image display panel, when the color filter is arranged outside of the base plate, and the resultant colored image display surface is observed in an oblique direction, an undesirable shear in colored images occurs in response to the thickness of the base plate, and thus an angle of the visual field becomes narrow.

The above-mentioned disadvantages can be removed by arranging the color filter at a location inside of the base plate and right above or below an ITO electrode adjacent to the liquid crystal material layer, but this arrangement of the color filter is disadvantageous in that a large drive voltage is required to operate the display devise or the formation of the ITO electrode over the color filter is difficult

Japanese Unexamined Patent Publication Nos. 62-28,711 and 62-28,712 disclose a liquid crystal display devise for colored images, having a liquid crystal material layer in which a number of microcapsules consisting of a liquid crystal material encapsulated with a colored polymeric material in the form of fine particles, is dispersed in a transparent polymeric binder, or in which a number of microcapsules comprising a liquid crystal material encapsulated with a colored polymeric material in the form of fine particles in a transparent polymeric material is dispersed in a colored polymeric binder.

In the above-mentioned display devices, the light transmitted through the devices is colored in the absence of an electric field, but is not substantially colored in the presence of an electric field.

Namely, in the above-mentioned display devices, it is difficult to completely or substantially shut out the light, and therefore, the conventional color display device having red, blue and green colored liquid crystal material layers exhibits an unsatisfactory contrast and the displayed colored images exhibit an unsatisfactory color vividness.

Japanese Unexamined Patent Publication No. 64-91,125 discloses liquid crystal display devices having a liquid crystal material layer in which a liquid crystal material is dispersed in the form of fine particles in a visible ray-absorbing medium. In these display devices, the display surface becomes dark in the absence of an electric field because the light is absorbed by the liquid crystal material

layer, and appears bright in the presence of an electric field because the light is transmitted through the liquid crystal material layer.

When these liquid crystal display devices are equipped with a color filter, it is possible to display colored images with a good contrast, but these display devices have the same disadvantages as described above.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a liquid crystal display panel for displaying colored images with a good contrast, while controlling a visible ray-transmission therethrough.

The above-mentioned object can be attained by the liquid crystal display panel of the present invention, which comprises:

a first transparent base;

a first transparent electrode arranged on the first base;

a second-transparent base arranged in parallel to and spaced from the first base,

a second transparent electrode arranged on the second base and facing and spaced from the first electrode; and

a liquid crystal material layer interposed between the first electrode and the second electrode and comprising a polymer dispersed liquid crystal material which comprises (a) a polymeric medium comprising a transparent polymeric material, (b) a liquid crystal material surrounded by surface means or a matrix consisting of the polymeric medium, and (c) a coloring material contained in at least one member selected from the group consisting of the polymeric medium and the liquid crystal material.

In a preferable embodiment of the liquid crystal display panel of the present invention, the polymeric medium further comprises a visible ray-absorbing material evenly mixed in the polymeric material, and the liquid crystal material contains the coloring material.

In another preferable embodiment of the liquid crystal display panel of the present invention, the liquid crystal material further contains a pleochroic dye.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an explanatory cross-sectional profile of a portion of an embodiment of the liquid crystal display panel of the present invention;

Fig. 2 is an explanatory cross-sectional profile of a portion of an embodiment of the liquid crystal display panel of the present invention for displaying full colored images; and

Fig. 3 is an explanatory cross-sectional profile of a portion of another embodiment of the liquid crystal display panel of the present invention for displaying full colored images.

DESCRIPTION OF TEE PREFERRED EMBODIMENTS

Figure 1 shows an explanatory cross-sectional profile of a portion of an embodiment of the liquid crystal display panel of the present invention having a liquid crystal material layer composed of a polymer dispersed liquid crystal material.

In Fig. 1, a first transparent base plate 1 and a second transparent base plate 2 are arranged in parallel to and spaced from each other, a first transparent electrode 3 is arranged on the first base plate 1, and a second transparent electrode 4 is arranged on the second base plate 2 and faces and is spaced from the first electrode 3.

A polymer dispersed liquid crystal material layer 5 is interposed between the first electrode 3 and the second electrode 4. In this liquid crystal material layer 5, a liquid crystal material is dispersed in the form of fine particles 6 in a polymeric medium 7 comprising a transparent polymeric material.

In the present invention, a coloring material is contained in at least one member selected from the liquid crystal material 6 and the polymeric medium 7.

The polymer dispersed liquid crystal material usable for the present invention is preferably selected from (1) the above-mentioned NCAP type liquid crystal materials, (2) the thermoplastic resin latex-containing liquid crystal materials, (3) the epoxy resin-containing liquid crystal materials and (4) the continuous network type liquid crystal materials.

The polymeric medium in the polymer dispersed liquid crystal material layer comprises a transparent polymeric material comprising at least one member selected from for example, polyvinyl alcohol, polymethylmethacrylate, ultraviolet ray-cured acrylic polymers, polyvinylchloride, and polyvinylidene chloride.

The liquid crystals usable for the present invention are not restricted to a specific type of liquid crystals and preferably selected from nematic liquid crystals, cholesteric liquid crystals and smectic liquid crystals. Preferably, the liquid crystal material is present in an amount of 1 to 10 times, more preferably 2 to 5 times the weight of the polymeric medium.

In the polymer dispersed liquid crystal material layer, the polymeric medium and/or the liquid crystal material contains a coloring material. The coloring material is not limited to a specific type or color of dyes or pigments, unless it is a pleochroic dye. For example, the coloring material comprises at least one member selected from solvent-soluble

red dyes, for example, Solvent Red 1 and Solvent Red 3; solvent-soluble green dyes, for example, Solvent Green 3; solvent-soluble blue dyes, for example, Solvent Blue 3, and Solvent Blue 11; red pigments, for example, CROMOPHTAL RED A2B (trademark, made by Ciba Geigy CO.); green pigments, for example, Heriogen Green G (trademark, made by BASF); and blue pigments, for example, Heriogen Blue B (trademark, made by BASF).

The coloring material is present preferably in an amount of 0.1 to 10%, more preferably 1 to 8%, based on the weight of the liquid crystal material.

In a preferable embodiment of the liquid crystal display panel of the present invention, the polymeric medium in the polymer dispersed liquid crystal material layer further comprises a visible ray-absorbing material, in addition to the transparent polymeric material, and the liquid crystal material contains the coloring material.

The visible ray-absorbing material comprises at least one member selected from black dyes and pigments. The black dyes and pigments are not limited to a specific type of dyes and pigments. For example, the visible ray-absorbing material comprises at least one member selected from solvent-soluble black dyes, for example, Solvent Black 3; disperse black dyes, for example, Disperse Black 28; black pigments, for example, carbon black and titanium black. The black dyes or pigments may be mixtures of red, blue and yellow dyes or pigments.

Preferably, the visible ray-absorbing material is present in an amount of 1 to 20%, more preferably 2 to 10%, based on the weight of the polymeric material.

In the above-mentioned embodiment, when a voltage is applied to the polymer dispersed liquid crystal material layer to create an electric field, a colored light is transmitted through the liquid crystal material layer, and in the absence of the electric field the display surface becomes dark.

The liquid crystal display panel as indicated in Fig. 2 comprises a first transparent base plate 11, a second transparent base plate 12 facing and spaced from the first base plate 11, a plurality of transparent picture element electrodes 13a, 13b and 13c arranged on the first base plate 11, a plurality of signal lines 14 for supplying electric signals to the picture element electrodes, arranged adjacent to and spaced from the picture element electrodes on the first base plate 11, a plurality of varistor layers 15 comprising fine varistor particles and a binder and electrically connecting the picture element electrodes 13 to the signal lines 14, a transparent scanning electrode 16 arranged on the second base plate 12 and facing and spaced from the picture element electrodes 13, and a plurality of polymer dispersed liquid crystal material layers 17a, 17b and 17c, interposed between the picture element electrodes 13 and the scanning electrode 16.

The liquid crystal material layer 17a comprises a liquid crystal material containing a red coloring material and dispersed in the form of a number of fine particles 18a in a polymeric medium 19a comprising a transparent polymeric material and a visible ray-absorbing material mixed into the polymeric material.

The liquid crystal material layer 17b is the same as the above-mentioned layer 17a, except that the liquid crystal material particles 18b contain a green coloring material.

The liquid crystal layer 17c is the same as the above-mentioned layer 17a, except that the liquid crystal material particles 18c contain a blue coloring material.

Therefore, the picture element electrodes 13a, 13b and 13c are respectively employed for displaying red, green or blue colored images.

The picture element electrodes and the signal lines can be formed by a conventional patterning method. Also, the varistor layers can be formed by a conventional screen printing method.

When a voltage is applied to the liquid crystal material layer 17a, 17b or 17c, to create an electric field, a red, green or blue colored light is transmitted through the corresponding liquid crystal material layer to form a colored image.

When the voltage is released, most of the incident light is absorbed by the liquid crystal material layer 17a, 17b or 17c, and thus no colored image is formed.

In another preferable embodiment of the liquid crystal display panel of the present invention, the liquid crystal material contains a pleochroic dye. Also, at least one member of the liquid crystal material and the polymeric medium contains a non-pleochroic coloring material.

The pleochroic dye can be selected from conventional pleochroic dyes usable for conventional liquid crystal display devises, for example, PLEOCHROIC DYE S301 (black), S344 (black), S424 (black), S430 (black), M370 (red) and M141 (blue) (made by Mitsui Toatsu Senryo K.K.). Preferably, the pleochroic dye is present in an amount of 0.1 to 10% based on the weight of the liquid crystal material.

In this type of liquid crystal display panel in which the liquid crystal material contains non-plechroic red dye and pleochroic black dye, when no voltage is applied to the liquid crystal material layer, most of the incident light is absorbed by the pleochroic black dye in the liquid crystal material, and thus the display surface of the panel looks dark red. When a voltage is applied to the liquid crystal material layer to create an electric field,

most of the incident light is colored red by the non-pleochroic red dye and transmitted through the liquid crystal material layer, and thus the display surface of the panel looks bright red.

When the liquid crystal material contains a green pleochroic dye, a blue pleochroic dye and a red non-pleochroic dye, the display surface of the panel looks dark or black in the absence of an electric field, and looks red in the presence of an electric field.

In the liquid crystal display panel as indicated in Fig. 3, the liquid crystal material particles 18a, 18b and 18c contain a pleochroic black dye, and at least one of the polymeric mediums 19a, 19b and 19c and the liquid crystal materials 18a, 18b and 18c contains a non-pleochroic coloring material. Also, in this panel of Fig. 3, black masks 20 are arranged on the second base plate 12 and between the liquid crystal material layers, 17a, 17b, 17c .... The black masks 20 are effective for enhancing the contrast, because it can inhibit a leakage of light when transmitted through the gaps between the liquid crystal material layers 17a, 17b and 17c.

When a voltage is applied to each liquid crystal material layer 17a, 17b or 17c, a colored light transmits through the liquid crystal material layer. Therefore, the liquid crystal display panel can display colored images without using color filters.

EXAMPLES

The present invention will be further illustrated in detail by the following specific examples, which is no way limit the scope of the invention.

Example 1

Carbon black in an amount of 20 mg was evenly dispersed in 1 ml of water, and the resultant aqueous dispersion was mixed to 4 g of a 10% aqueous solution of polyvinyl alcohol. After gradually stirring, to the mixture was added 1.5 g of material LIQUID CRYSTAL E-44 (available from BDH Co.) in which 30 mg of Solvent Red 3 were dissolved. The resultant admixture was stirred at high speed to provide a red-colored emulsion R and then filtered through a filter G4 to remove coarse particles of the carbon black.

A green-colored emulsion G was prepared by the same procedures as mentioned above, except that Solvent Green 3 was employed in place of the red dye.

A blue-colored emulsion 13 was prepared by the same procedures as mentioned above, except that Solvent Blue 11 was employed in place of the red dye.

In the production of the liquid crystal display panel as indicated in Fig. 2, the emulsions R, G and B are coated, respectively and separately from each other, on the predetermined portions of the scanning electrode 16 on the second base plate 12 by a screen printing method, and dried, to provide red, green and blue-colored liquid crystal material layers 17a, 17b, and 17c, each having a thickness of 14 μm.

Then, a first base plate 11 having transparent picture element electrode 13a, 13b, and 13c, signal lines 14 and varistor layers 15 was superposed on and bonded to the second base plate 12 having the scanning electrode 16 and the liquid crystal material layers 17a, 17b and 17c, in such a manner that the liquid crystal material layers 17a, 17b and 17c were interposed respectively between the picture element electrodes 13a, 13b, and 13c and the scanning electrode 16.

When a voltage was applied to the liquid crystal material layers 17a, 17b and 17c, red, green and blue-colored images were appeared on the display surface of the panel.

Example 2

Carbon black in an amount of 0.15 g was dispersed in 20 g of a 15% aqueous solution of polyvinyl alcohol by thoroughly stirring the solution and the resultant dispersion was filtered through a filter G5 to remove large particles of the carbon black.

The filtered dispersion was mixed with 12 g of dodecyl benzene, 3 g of n-butyl alcohol and 2 g of n-pentyl alcohol, and the mixture was stirred by a stirrer at a rotation speed of 600 r.p.m. for 10 minutes, to provide a black-colored, visible ray-absorbing emulsion.

Separately, a red-colored liquid crystal material R was prepared by mixing 5 g of the same liquid crystal material as mentioned in Example 1 with 100 mg of Solvent Red 3.

A green-colored liquid crystal material G was prepared by the same operation as mentioned above, except that Solvent Green 3 was employed in place of the red dye.

A blue-colored liquid crystal material B was prepared by the same operation as mentioned above, except that Solvent Blue 11 was used in place of the red dye.

The above-mentioned black-colored emulsion was coated on predetermined portions of the scanning electrode 16 of the second base plate 12 by a screen printing method and dried, to form dried black-colored polymeric layers having a thickness of 14 μm. The resultant layers on the second base plate were thoroughly washed with hexane at room temperature and dried, to form visible ray-absorbing polymeric medium layers having network-shaped pores formed therein.

The visible ray absorbing polymeric medium layers were coated respectively with the red, green and blue-colored liquid crystal materials R, G and B in an amount of 1.2 mg/cm^2 and the coated layers were placed under a reduced pressure to allow the liquid crystal materials R, G and B to penetrate into the network-shaped pores in the polymeric medium layers, to form red, green and blue-colored polymer dispersed liquid crystal material layers.

The second base plate having the scanning electrode and the liquid crystal material layers was superimposed on the first base plate having the picture element electrodes, signal lines and varistor layers in the same manner as mentioned in Example 1.

The resultant liquid crystal panel could display clear red, green and blue-colored images upon application of a voltage, without using color filters.

Example 3

A 12% polyvinyl alcohol aqueous solution in an amount of 2.5 g was mixed with a red-colored liquid crystal material prepared by dissolving 20 mg of PLEOCHROIC BLACK DYE S301 (available) from Mitsui Toatsu Senryo K.K.) and 20 mg of Solvent Red 3 in 1.0 g of a LIQUID CRYSTAL E-44 (available from BDH Co.) The mixture was stirred at a high speed to provide an emulsion.

The emulsion was coated on a surface of a transparent electrode on a first ITO glass base plate by a doctor-blade coating method and the resultant emulsion layer was dried to form a liquid crystal material layer.

A second ITO glass base plate having a transparent electrode arranged thereon was placed on the liquid crystal material layer of the first ITO glass base plate so that the liquid crystal material was interposed between the transparent electrodes on the first and second base plates, to provide a liquid crystal display panel.

When a voltage was not applied to the panel, the display surface of the panel looked dark red. When a voltage of 70 volt was applied, the display surface of the panel looked bright red. The contrast ratio was 46 at a wave length of 610 nm.

Example 4

A liquid crystal display device as shown in Fig. 3 was prepared as follows.

A 10% polyvinyl alcohol aqueous solution in an amount of 4 g was mixed with a red-colored liquid crystal material prepared by dissolving 30 mg of PLEOCHROIC BLACK DYE S 301 (made by Mitsui Toatsu Senryo K.K.) and 20 mg of Solvent Red 3 in 1.5 g of LIQUID CRYSTAL E-44 (made by BDH Co.). The mixture was stirred at high speed to provide an emulsion R.

Also, a green-colored emulsion G was prepared in the same manner as mentioned above, except that Solvent Green 3 was employed in place of the red dye.

Further, a blue-colored emulsion B was prepared in the same manner as mentioned above, except that Solvent Blue 11 was employed in place of the red dye.

As indicated in Fig. 3, a transparent scanning electrode 16 was arranged on a second transparent base plate 12 and a plurality of black mask layers 20 were formed on predetermined portions of the scanning electrode 16 by coating a coating paste (ink) containing a black pigment and drying. Then, the emulsions R, G and B were respectively applied to predetermined portions between the black mask layers 20 on the scanning electrode 16 by a screen printing method, and dried, to form red, green and blue-colored polymer dispersed liquid crystal material layers 17a, 17b and 17c each having a thickness of 14 μm.

The liquid crystal display panel was provided by superposing the second base plate 12 having the scanning electrode 16, the black mask layers 20 and the liquid crystal material layers 17a, 17b and 17c on a first base plate 11 having picture element electrodes 13a, 13b, and 13c, signal lines 14 and varistor layers 15 in the same manner as described in Example 1.

The resultant liquid crystal display panel displayed clear red, green and blue-colored images with good contrast in the presence of an electric field. In the absence of an electric field, the display surface of the panel was dark.

Example 5

The same procedures as in Example 4 were carried out with the following exceptions.

A red-colored emulsion R was prepared by evenly dispersing 80 mg of a red pigment (available under the trademark of CROMOPHTAL RED A2B, from Ciba Geigy Co. in 4 g of a 10% polyvinyl alcohol aqueous solution, mixing the resultant dispersion with 1.5 g of LIQUID CRYSTAL E-44 (made by BDH Co.) containing 30 mg of PLEOCHROIC BLACK DYE S201 (made by Mitsui Toatsu Senryo K.K.) and stirring the mixture at high speed.

A green-colored emulsion G was prepared by the same procedures as mentioned above, except that the red pigment was replaced by 60 mg of a green pigment available under the trademark of HELIOGEN GREEN G from BASF.

A blue-colored emulsion B was prepared by the same procedures as mentioned above, except

that the red pigment was replaced by 50 mg of a blue pigment available under the trademark of HELIOGEN BLUE B, from BASF.

The resultant liquid crystal display panel displayed clear red, green and blue-colored images with a satisfactory contrast in the presence of an electric field.

Claims

1. A liquid crystal display panel for colored images, comprising:

   a first transparent base;

   a first transparent electrode arranged on the first base;

   a second transparent base arranged in parallel to and spaced from the first base;

   a second transparent electrode arranged on the second base and facing and spaced from the first electrode; and

   a liquid crystal material layer interposed between the first electrode and the second electrode and comprising a polymer dispersed liquid crystal material which comprises (a) a polymeric medium comprising a transparent polymeric material, (b) a liquid crystal material surrounded by surface means or a matrix consisting of the polymeric medium, and (c) a coloring material contained in at least one member selected from the group consisting of the polymeric medium and the liquid crystal material.

2. The liquid crystal display panel as claimed in claim 1, wherein the polymeric medium further comprises a visible ray-absorbing material evenly mixed in the polymeric material, and the liquid crystal material contains the coloring material.

3. The liquid crystal display panel as claimed in claim 1, wherein the liquid crystal material contains a pleochroic dye.

4. The liquid crystal display panel as claimed in claim 1, wherein the coloring material consists of a member selected from the group consisting of red, green, and blue dyes and pigments.

5. The liquid crystal display panel as claimed in claim 1 or 2, wherein the coloring material is present in an amount of 0.1 to 10% based on the weight of the liquid crystal material.

6. The liquid crystal display panel as claimed in claim 2, wherein the visible ray-absorbing material comprises at least one member selected from the group consisting of black dyes and pigments.

7. The liquid crystal display panel as claimed in claim 2, wherein the visible ray-absorbing material is present in an amount of 1 to 20% based on the weight of the polymeric material.

8. The liquid crystal display panel as claimed in claim 3, wherein the pleolchroic dye is present in an amount of 0.1 to 10% based on the weight of the liquid crystal material.

9. The liquid crystal display panel as claimed in claim 1, wherein the liquid crystal material is present in an amount of 1 to 10 times the weight of the polymeric medium.

Fig. 1

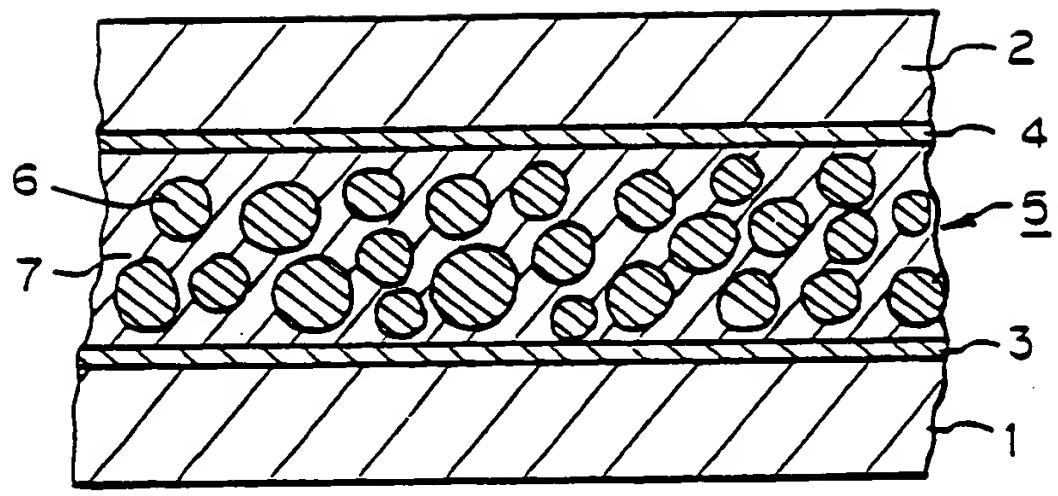


Fig. 2

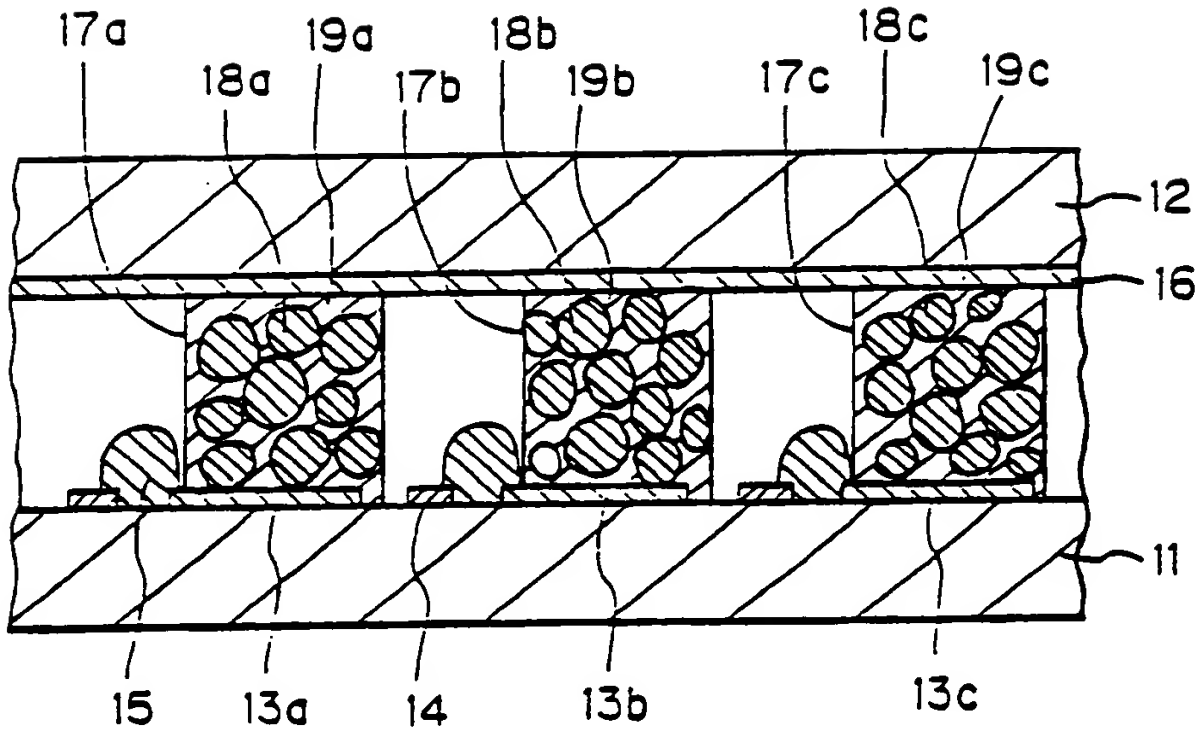


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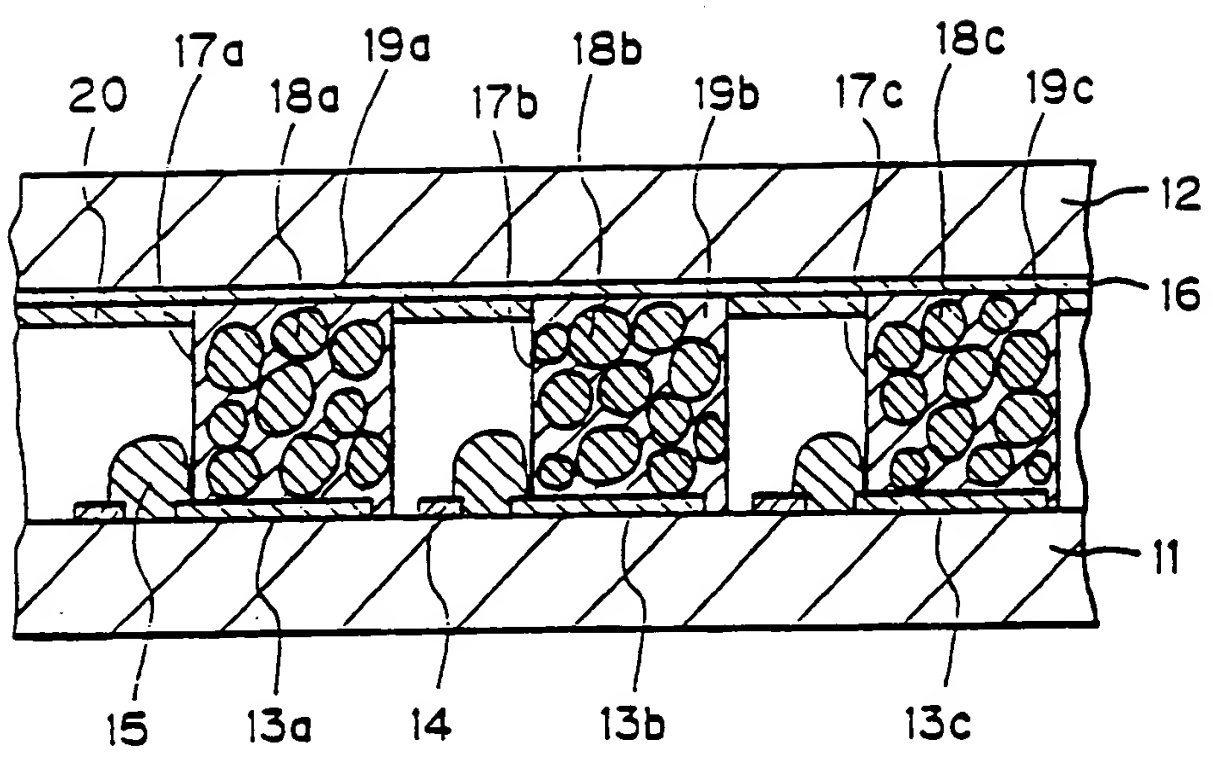
Fig. 3



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(54) Semitransparent electrophoretic information displays (EPID) employing mesh like electrodes.

(57) An electrophoretic display (10) includes a plurality of intersecting grid (23) and cathode (25) lines which are spaced one from the other by means of an insulating material (22). The grid and cathode lines are associated with an anode electrode (26) which constitutes a planar glass plate (27) having deposited thereon a thin layer of ITO or a similar metal. Interposed between the cathode and grid structure (22-25) and the anode plate (26) is a mesh electrode (30) which is relatively of the same size as the anode plate. Control voltages are applied to the mesh structure(30) and the anode electrode (26) to further control particle propagation. The conventional anode structure may be entirely replaced with the mesh-like structure to provide an electrophoretic display which can be optimumly illuminated by back lighting (40).

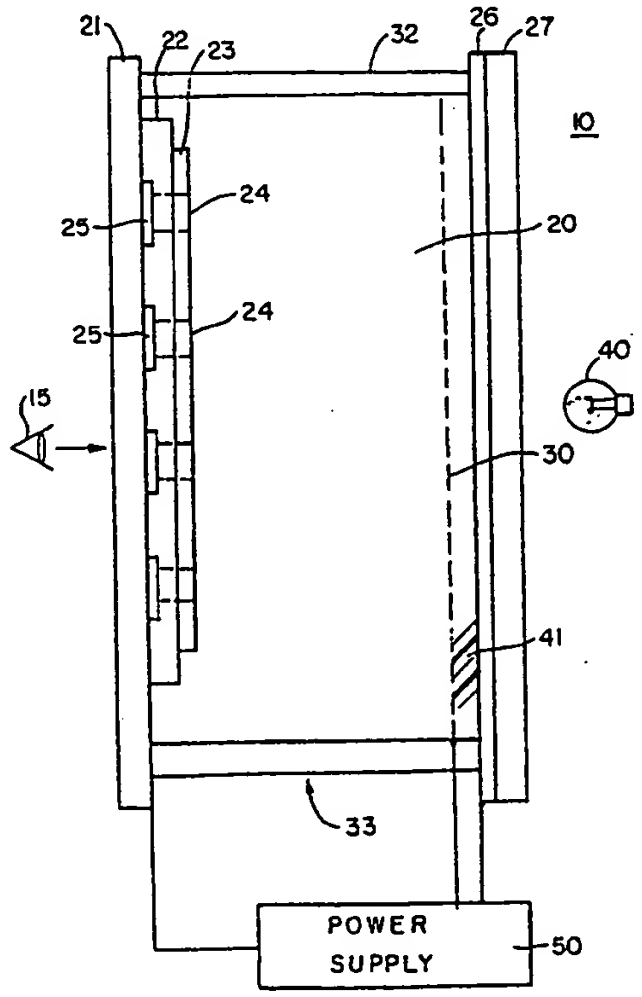

FIG. 1

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Background of the Invention

This invention relates to electrophoretic information displays (EPID) in general and more particularly to an EPID display employing a mesh like electrode.

The prior art is replete with a number of various patents and articles concerning electrophoretic displays. Such electrophoretic displays have been widely described and disclosed in the prior art, and essentially the assignee herein, namely--Copytele, Inc. of Huntington Station, New York, has recently developed an electrophoretic display which has an image area of approximately 11 x 8 1/2 inches and is designed to be used either as a separate display or to be combined with other displays. The company has the ability to combine as many as four such displays to create image areas as large as approximately 22 x 17 inches.

The information on such displays can be changed either locally or remotely and can be viewed at an angle of nearly 180°. Such displays have extremely high resolution and can accommodate over 160,000 pixels within an image area of approximately 2.8 inches diagonally. In regard to such displays, reference is made to U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS to Frank J. DiSanto and Denis A. Krusos and assigned to Copytele, Inc., the assignee herein.

In that patent there is described an electrophoretic display panel which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line pattern is filled with an electrophoretic dispersion containing chargeable pigment particles.

When a voltage is impressed on the X and Y lines, pigment particles which are located in wells or depressions between the X and Y pattern are caused to migrate towards the conductive plate and are deposited on the plate in accordance with the bias supplied to the X and Y conductors.

There is described in that patent an electrophoretic dispersion suitable for operation with the display as well as techniques for fabricating the display. Hence, in this manner the displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution and relatively low power. As indicated, the above-noted patent and others include information concerning the fabrication, operation and resolution of such displays.

See also U.S. Patent 4,772,820 entitled "Monolithic Flat Panel Display Apparatus" issued on September 20, 1988 to Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows an electrophoretic display as well as methods for fabrication and operating such a display.

See also U.S. Patent 4,742,345 entitled "Electrophoretic Display Panel Apparatus And Methods Therefor" by Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows such a display having improved alignment and contrast characteristics and structure and methods for aligning and operating such a display.

See also U.S. Patent 4,746,917 entitled "Methods And Apparatus For Operating An Electrophoretic Display Between A Display And A Non-Display Mode" issued on May 24, 1988 to Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows and describes a power supply circuit for operating such a display between a display and a non-display mode.

As one can ascertain from the prior art, the electrophoretic display has been thoroughly investigated and essentially it is a continuing object to provide more reliable operation as well as to provide displays which permit greater control of the image producing pigment particles as propagating within the display.

The electrophoretic effect is associated with working fluids which includes a dispersion of electrophoretic particles. These particles may be fabricated from an opaque dielectric material or a pigment which particles are suspended in a colored non-conducting suspension medium. The particles preferably are uniformly distributed throughout the suspension medium and the contrast between the particles and the suspension medium is the mechanism which enables one to formulate an image.

When the composite material is subjected to an electric field, the particles are caused to move electrophoretically in the direction of either the cathode or the anode. These particles are deposited upon the respective structure to cause that structure to assume the color of the particle which, for example, may be grey, white or some other color depending upon the pigment utilized. Hence, as one can ascertain, by selectively moving the particles one can produce images based on the migration and orientation of the particles with respect to a charged surface. As indicated, this effect is well known as for example ascertained by the above-noted prior art and many of the references cited against such prior art.

As one will immediately understand, it is a

major object in all such displays to produce a reliable display as well as to provide a uniform and rapid movement of the particles. In prior art displays, extreme difficulty was experienced when attempting to move the particles at high speeds and to further control the particles so that a uniform image is displayed. It was a further difficulty to utilize lighting as back lighting with such a display due to the fact that the anode electrode, which is a planar electrode, is not totally transparent but essentially is semi-transparent and hence any attempts to back light the displays of the prior art were difficult to accommodate.

It is an object of the present invention to provide a mesh electrode which mesh electrode provides greater control of the pigment particles and therefore provides a display which is more reliable and easier controlled than those of the prior art.

It is a further object to provide an electrophoretic display having a mesh electrode to enable back lighting of the display and hence overcoming many of the prior art problems.

Summary of the Invention

In an electrophoretic display of the type having an XY matrix assembly consisting of a grid of vertical lines intersected by a grid of horizontal lines and insulated therefrom, with an anode electrode spaced from said matrix assembly and with an electrophoretic dispersion located between said anode and matrix assembly, the improvement therewith of a mesh like electrode structure located between said matrix assembly and said anode electrode.

Brief Description of the Figures

FIG. 1 is a partial plan view of an electrophoretic display apparatus according to this invention; and

FIG. 2 is a plan view of an electrophoretic display showing certain aspects of the present invention.

Detailed Description of the Figures

Referring to Fig. 1, there is shown a side view of a typical electrophoretic display 10.

The display 10 of Fig. 1 is filled with an electrophoretic solution or dispersion 20 which includes light colored pigment particles suspended in a dark dye solution. For examples of such solutions and techniques, reference is made to the above-cited U.S. Pat. No. 4,655,897.

As seen from Fig. 1, the display contains a front glass sheet or viewing surface 21. The eye of viewer 15 is shown viewing the front of the display via the glass sheet 21. Disposed upon the glass sheet 21 by suitable etching techniques are columns 23 and rows 25. The rows are made from an extremely thin layer of indium-tin-oxide (ITO) while the columns are made from thin layers of aluminum. These patterns are provided in extremely thin layers and essentially constitute an X Y matrix. The layers of ITO are relatively thin, being approximately 300 Angstroms in thickness. In any event, the grid or columns and the rows or cathodes are spaced from one another and insulated from one another by means of an insulating layer 22.

While the grids and cathodes have been specified in terms of rows and columns, it is immediately apparent that the terms can be interchanged as desired. In any event, each of the grid and cathode intersections are associated with a pigment well 24. These wells contain the electrophoretic solution which is in the cavity 20. The columns and rows are separated from a back electrode 26 or anode plate which is also fabricated on a sheet of glass 27 and constitutes a thin layer of ITO. The anode electrode is essentially an extremely thin planar layer of ITO deposited upon a sheet of glass, as can be seen in many of the above-cited references. The spacers such as 32 and 33 can be implemented in many different ways and essentially serve to mechanically separate the display cell or panel 10.

Shown positioned between the grid cathode structure and the anode 26 is a mesh electrode 30. The mesh electrode 30 is fabricated from a thin sheet of stainless steel having a plurality of apertures therein to create a mesh or screen like structure. The electrodes of the display are biased by means of the power supply 50. The supply 50 operates similar to that shown in the above cited patent U.S. 4,746,917. As indicated, the anode electrode 26 is a thin layer of ITO which is semi-transparent and highly reflective. The electrode 30 contains a plurality of apertures and due to the mesh like construction will allow light to pass via the apertures. The configuration described employs the anode 26 with the mesh like electrode 30. This configuration permits greater control of the pigment particles due to the various ratios of the potential applied to the electrode 30 as compared to that applied to the anode 27.

An extremely important aspect of the electrophoretic display which will enhance operation even further, is the possibility of back lighting the display. As seen in FIG. 1, there is shown a bulb 40 which appears at the back of the display while the viewer's eye 15 is at the front of the display. If the bulb is illuminated then the pattern, which is disposed, upon the cathode surface, will stand out due to the fact that the light source 40 will tend to increase the contrast of the display. The electrophoretic solution can be illuminated by means of the light source as 40 thus creating greater contrast

and enabling the display to be even clearer.

As one can understand, based on the fact that the display of FIG. 1 includes both the mesh electrode 30 and the anode electrode 27 some pigment stops at the mesh electrode and some pigment continues and stops at the anode electrode. Thus the amount of illumination from the back is somewhat attenuated. In order to avoid this, a display has been constructed which essentially eliminates the thin planar anode electrode. Thus the configuration of the display is as follows. Layers 26 and 27 are both glass or a single sheet of glass with the mesh electrode 30 deposited upon the glass sheet or positioned as shown in FIG. 1, thus entirely eliminating the planar anode electrode but substituting therefor a mesh electrode. Since all the pigment stops at the mesh anode 30 much more back lighting illumination passes through the cell via the mesh structure.

The configuration, as shown in FIG. 1, may be simply constructed using methods as taught by many of the references cited above. For example, a layer of insulating material is first coated on top of the ITD layer 27 which ITO layer is deposited upon the glass substrate 27. A layer of metal is then coated on the insulating material. This metal layer is patterned by a photolithographic technique to produce a mesh pattern. The insulating material is then plasma etched to produce the wells or apertures which therefore communicate between the mesh and the anode with the mesh being insulated from the anode by means of an insulating layer 41 as shown in FIG. 1.

In order to operate the display of FIG. 1, normal grid and cathode voltages are employed, as indicated and shown in the above references. The voltage employed on the mesh electrode or the mesh anode is a relatively high voltage designated as for example +HV and this voltage is applied during the hold and write modes of the display. The electrode 26 designated as the anode, is connected to a voltage which is $+HV - {}_{\Delta}V$. The voltage ${}_{\Delta}V$ is selected to be between 5 and 10% less than the voltage +HV. Thus the mesh 30 is positive relative to the anode 27 and hence the pigment particles stop at the mesh permitting a maximum amount of illumination from the back lighting source 40. It is of course understood that if the anode 26 is completely eliminated, the mesh electrode 30 can be deposited directly on the glass sheet 27 by the above-described methods as should be obvious to those skilled in the art. In this manner a maximum amount of light will pass through the apertures created in the mesh.

In operation of the display the pigment particles contained in the electrophoretic solution 20 are brought forward towards the viewing surface in order to fill the wells formed between the rows and columns. Once a well such as well 24 is filled. the voltage on the rows, columns, and anode is then set such that the wells remain filled but pigment spaced between the rear cover and the columns are swept unto the mesh (30) and anode (26). The viewing side 21 is the color of the pigment in the wells.

By selectively applying voltages to the rows and columns, the pigment in individual wells 24 (at the intersection of the rows and columns selected) is forced out of the wells exposing the dye solution and making that intersection (pixel) dark. The removal of the pigment from the wells is not instantaneous but requires a period of time which depends upon the dimension of the cell or display, the fluid components, and the various applied voltages. The use of the mesh electrode 30 operates to more rapidly propel the pigment particles due to the increased field provided by the additional mesh electrode and hence affords a more rapid removal of particles from the wells. This is also due to the mesh like construction as the apertures in the mesh electrode enhance the field strength.

Referring to Fig. 2, there is shown a planar plan view of an enlarged representation of an electrophoretic display cell or panel according to Fig. 1.

As seen in Fig. 2, each well 24 is accommodated between an intersection of a column 23 which is insulatively separated from a row layer of ITO 25. The well 24 forms a pixel area which is indicative of an X Y intersection on the ITO display.

The pigment particles of course travel between the cathode and anode. As shown in FIG. 2, the anode may be the mesh-like structure 30 or may constitute a separate mesh structure fabricated directly on the layer of glass as above described or a stainless steel mesh 30 may be interposed between the anode and a cathode grid structure as indicated. As seen in FIG. 2, the mesh contains a plurality of apertures which are for example circular holes. It is immediately understood that the mesh may contain any shaped apertures, such as rectangular, square, triangular and so on. Essentially the apertures are extremely small. The mesh is a hardened stainless steel mesh available from many sources. Each aperture is between 10 to 30 mils in diameter with the space between apertures being of the same magnitude, namely 10 to 30 mils. Preferably the apertures are approximately 15 mils in diameter with the space between the apertures about 15 to 20 mils. Hence, as one can ascertain, due to the extremely large number of apertures and due to the spacing between apertures, the hardened stainless steel sheet appears as a total mesh-like structure which is integrally formed and highly conductive. Hence the same can act as an anode electrode or as an intermediate electrode to aid and assist in controlling the pigment particles.

As one can ascertain again from FIG. 1, due to the extremely transparent nature of the mesh-like structure, one can therefore direct light from a source 40 directly through the mesh when an additional ITO coated anode as 26 is not being employed. The above-noted mesh structure creates an electrophoretic display having superior operating characteristics over those provided in the prior art.

Claims

1. In an electrophoretic display of the type having an XY matrix assembly consisting of a grid of vertical oriented lines intersected by a grid of horizontally oriented lines and insulated therefrom, with an anode electrode spaced from said matrix assembly and with an electrophoretic dispersion located between said anode and matrix assembly, the improvement therewith of a mesh like electrode structure located between said matrix assembly and said anode electrode.

2. The electrophoretic display according to Claim 1 wherein said mesh like electrode replaces the anode electrode of said display.

3. The electrophoretic display according to Claim 1 wherein said anode electrode comprises a thin layer of ITO with said mesh like electrode located between said anode electrode and said matrix and operative when biased to further control electrophoretic particles.

4. The electrophoretic display according to Claim 3 wherein said mesh like electrode is a planar sheet of a conductive material having a plurality of apertures on the surface to form a mesh-like structure.

5. The electrophoretic display according to Claim 4 wherein said conductive material is stainless steel.

6. The electrophoretic display according to Claim 5 wherein said apertures are circular in shape, each having a diameter of between 10-30 mils and spaced one from the other between 10-30 mills.

7. The electrophoretic display according to Claim 1 further including a light source located in proximately to said anode electrode to cause light to pass through said anode electrode to said matrix structure for illuminating said display.

8. The electrophoretic display according to Claim 1 further including means for applying a higher positive potential to said mesh electrode than said anode electrode to cause pigment particles to migrate to and stop at said mesh electrode.

9. The electrophoretic display according to claim 1 wherein said anode electrode is deposited on a planar glass member.

10. The electrophoretic display according to Claim 2 wherein said mesh electrode is deposited on a planar glass member.

11. A method of operating an electrophoretic display with improved particle control, comprising the steps of:

placing a mesh electrode between the anode electrode and grid and cathode electrode structures;

applying a bias to said mesh electrode of a more positive potential than that applied to said anode electrode to cause pigment particles to propagate to and stop at said mesh electrode.

12. The method according to Claim 11 wherein said mesh electrode is a thin planar conductive sheet having a plurality of apertures formed therein to create a mesh like structure.

13. The method according to Claim 12 wherein said apertures are between 10-30 mils in diameter and spaced between 10-30 mils apart.

14. In an electrophoretic display of the type having an X-Y matrix of intersecting cathode and grid lines and an anode electrode separated from said matrix, with an electrophoretic dispersion located between said anode electrode and said matrix, the improvement comprising:

an anode electrode being a mesh like structure having a plurality of closely spaced apertures located on the surface thereof and adapted to receive an operating potential to cause pigment particles to migrate to said mesh during display operation.

15. The apparatus according to Claim 14 wherein said anode electrode is a conductive mesh like structure deposited upon a glass layer and separated therefrom by an insulator mesh layer.

16. The apparatus according to Claim 15 wherein said mesh like structure is a planar sheet of stainless steel having a plurality of closely

spaced apertures on the surface thereof.

17. The apparatus according to Claim 14 further including a second anode electrode insulated from said mesh like structure and said second anode electrode being a thin layer of a conductive material deposited on a layer of glass.

18. The apparatus according to Claim 17 wherein said thin layer of conductive material is ITO.

19. The apparatus according to Claim 16 wherein said apertures as distributed over the entire surface of said sheet are between 10-30 mils in diameter and separated one from the other by between 10-30 mills.

20. The apparatus according to Claim 19 wherein said apertures are circular in shape.

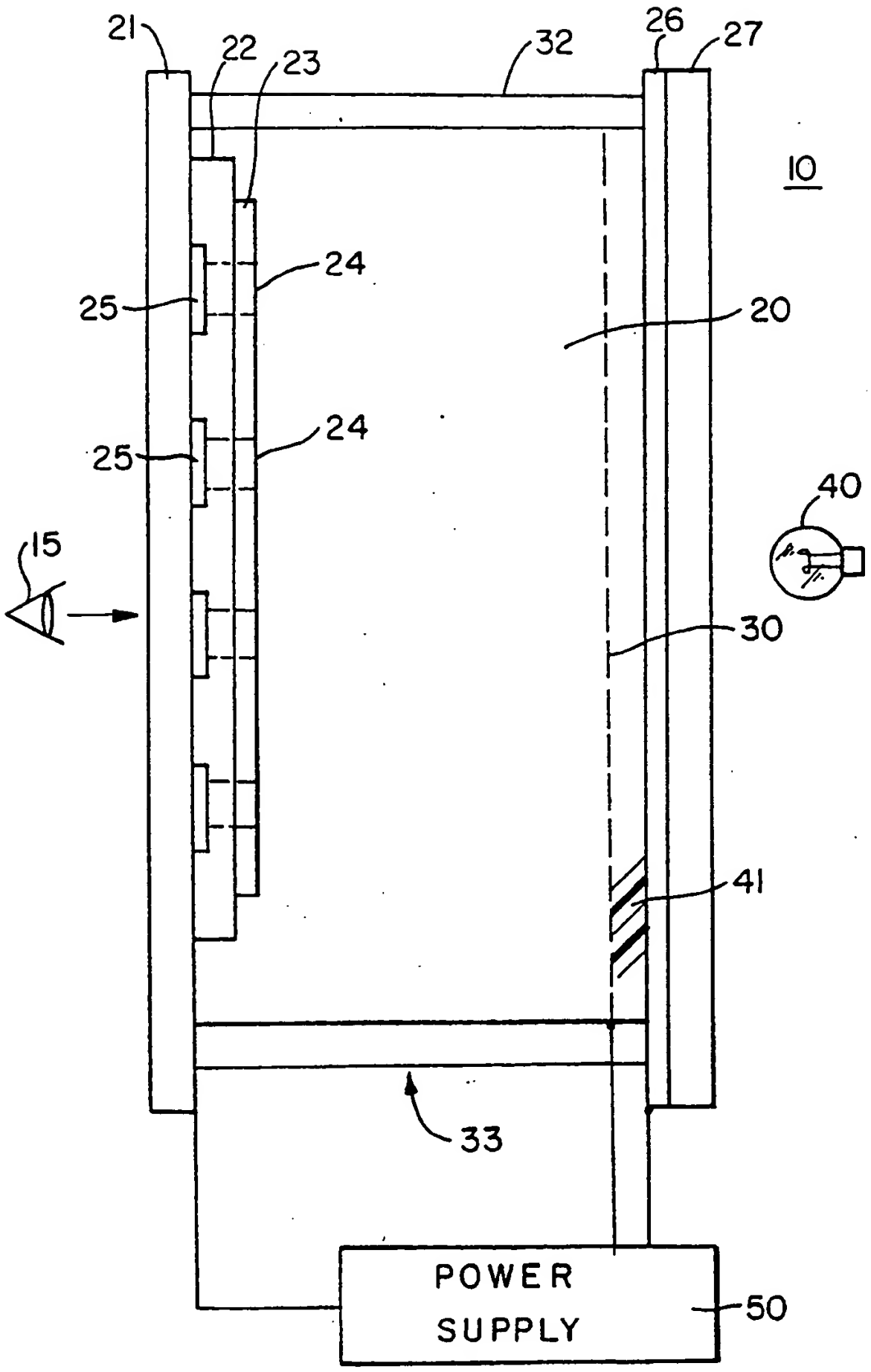

FIG. 1

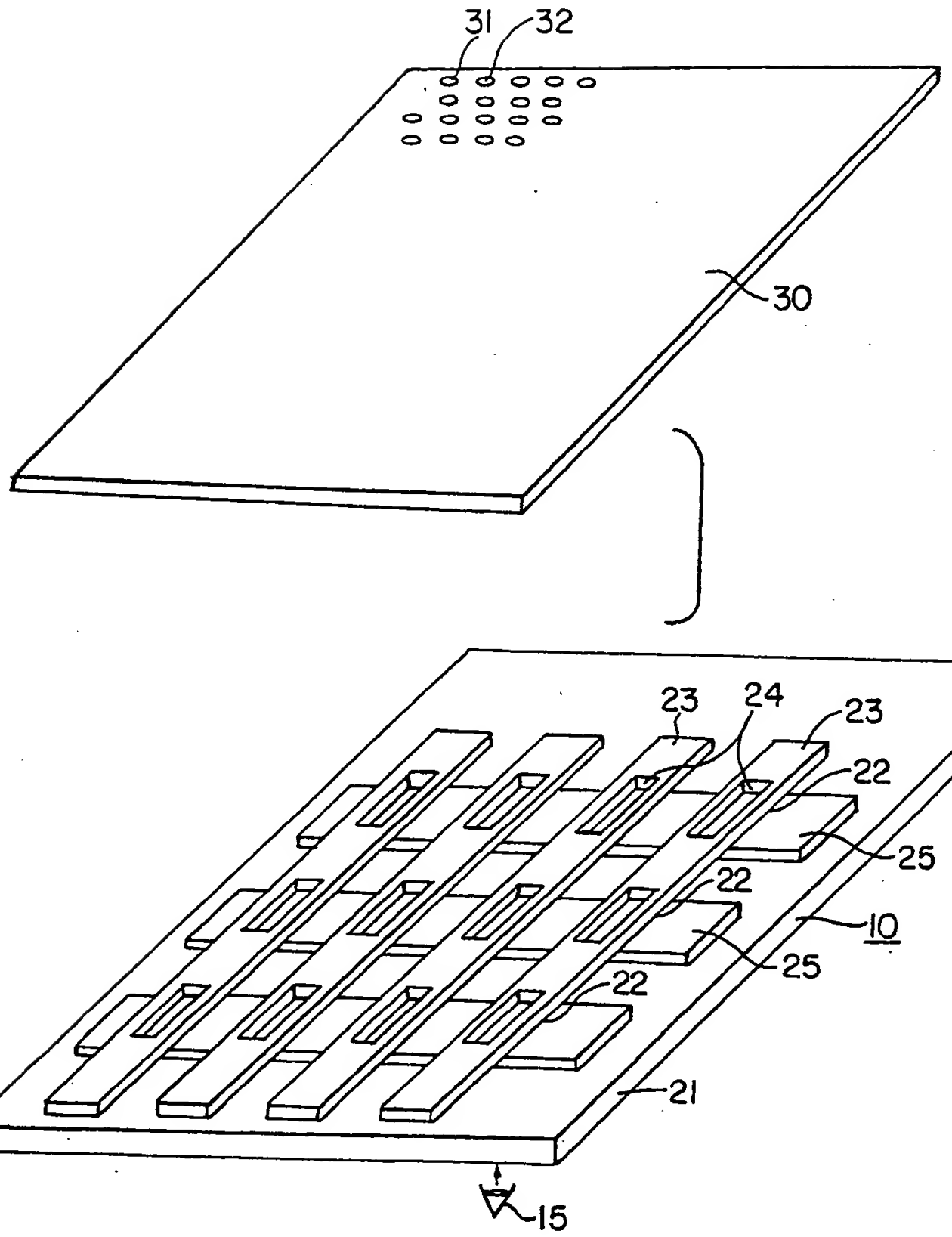

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 3210

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 655 897 (DI SANTO) * Column 2, line 51 - column 3, line 4; figures 1,2,6 *	1	G 02 F 1/167
A	US-A-4 071 430 (LIEBERT) * Column 2, line 50 - column 3, line 10 *	1-6,11-14	
A	PATENT ABSTRACTS OF JAPAN, vol. 13, no. 389 (P-925)[3737], 29th August 1989; & JP-A-1 137 240 (KINSEKI) 30-05-1989 * Whole document *	1	
A	EP-A-0 186 922 (PHILIPS) * Page 5, paragraph 1; figure 1 *	1,7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	21 November 90	WONGEL H.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

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(54) Semitransparent electrophoretic information displays (EPID) employing mesh like electrodes.

Divisional application 93112534.8 filed on 27/03/90.

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EP-A- 0 186 922
US-A- 4 071 430
US-A- 4 655 897
PATENT ABSTRACTS OF JAPAN, vol. 13, no. 389 (P-925)[3737], 29th August 1989; & JP-A-1 137 240

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Description

Background of the Invention

This invention relates to electrophoretic information displays (EPID) in general and more particularly to an EPID display employing a mesh like electrode.

The prior art is replete with a number of various patents and articles concerning electrophoretic displays. Such electrophoretic displays have been widely described and disclosed in the prior art, and essentially the assignee herein, namely--Copytele, Inc. of Huntington Station, New York, has recently developed an electrophoretic display which has an image area of approximately 28 x 21.6 cm (11 x 8 1/2 inches) and is designed to be used either as a separate display or to be combined with other displays. The company has the ability to combine as many as four such displays to create image areas as large as approximately 56 x 43.2 cm (22 x 17 inches).

The information on such displays can be changed either locally or remotely and can be viewed at an angle of nearly 180°. Such displays have extremely high resolution and can accommodate over 160,000 pixels within an image area of approximately 7.1 cm (2.8 inches) diagonally. In regard to such displays, reference is made to U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS to Frank J. DiSanto and Denis A. Krusos and assigned to Copytele, Inc., the assignee herein.

In that patent there is described an electrophoretic display panel which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line pattern is filled with an electrophoretic dispersion containing chargeable pigment particles.

When a voltage is impressed on the X and Y lines, pigment particles which are located in wells or depressions between the X and Y pattern are caused to migrate towards the conductive plate and are deposited on the plate in accordance with the bias supplied to the X and Y conductors.

There is described in that patent an electrophoretic dispersion suitable for operation with the display as well as techniques for fabricating the display. Hence, in this manner the displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution and relatively low power. As indicated, the above-noted patent and others include information concerning the fabrication, operation and resolution of such displays.

See also U.S. Patent 4,772,820 entitled "Monolithic Flat Panel Display Apparatus" issued on September 20, 1988 to Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows an electrophoretic display as well as methods for fabrication and operating such a display.

See also U.S. Patent 4,742,345 entitled "Electrophoretic Display Panel Apparatus And Methods Therefor" by Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows such a display having improved alignment and contrast characteristics and structure and methods for aligning and operating such a display.

See also U.S. Patent 4,746,917 entitled "Methods And Apparatus For Operating An Electrophoretic Display Between A Display And A Non-Display Mode" issued on May 24, 1988 to Frank J. DiSanto et al. and assigned to the assignee herein. This patent shows and describes a power supply circuit for operating such a display between a display and a non-display mode.

As one can ascertain from the prior art, the electrophoretic display has been thoroughly investigated and essentially it is a continuing object to provide more reliable operation as well as to provide displays which permit greater control of the image producing pigment particles as propagating within the display.

The electrophoretic effect is associated with working fluids which includes a dispersion of electrophoretic particles. These particles may be fabricated from an opaque dielectric material or a pigment which particles are suspended in a colored non-conducting suspension medium. The particles preferably are uniformly distributed throughout the suspension medium and the contrast between the particles and the suspension medium is the mechanism which enables one to formulate an image.

When the composite material is subjected to an electric field, the particles are caused to move electrophoretically in the direction of either the cathode or the anode. These particles are deposited upon the respective structure to cause that structure to assume the color of the particle which, for example, may be grey, white or some other color depending upon the pigment utilized. Hence, as one can ascertain, by selectively moving the particles one can produce images based on the migration and orientation of the particles with respect to a charged surface. As indicated, this effect is well known as for example ascertained by the above-noted prior art and many of the references cited against such prior art.

As one will immediately understand, it is a major object in all such displays to produce a reliable display as well as to provide a uniform and rapid movement of the particles. In prior art displays, extreme difficulty was experienced when attempting to move the par-

ticles at high speeds and to further control the particles so that a uniform image is displayed.

It is an object of the present invention to provide a mesh electrode which mesh electrode provides greater control of the pigment particles and therefore provides a display which is more reliable and easier controlled than those of the prior art.

Summary of the Invention

In an electrophoretic display of the type having an XY matrix assembly consisting of a grid of vertical lines intersected by a grid of horizontal lines and insulated therefrom, with an anode electrode spaced from said matrix assembly and with an electrophoretic dispersion located between said anode and matrix assembly, the improvement therewith of a mesh like electrode structure located between said matrix assembly and said anode electrode as defined in claims 1 and 9.

Brief Description of the Figures

FIG. 1 is a partial plan view of an electrophoretic display apparatus according to this invention; and

FIG. 2 is a plan view of an electrophoretic display showing certain aspects of the present invention.

Detailed Description of the Figures

Referring to Fig. 1, there is shown a side view of a typical electrophoretic display 10.

The display 10 of Fig. 1 is filled with an electrophoretic solution or dispersion 20 which includes light colored pigment particles suspended in a dark dye solution. For examples of such solutions and techniques, reference is made to the above-cited U.S. Pat. No. 4,655,897.

As seen from Fig. 1, the display contains a front glass sheet or viewing surface 21. The eye of viewer 15 is shown viewing the front of the display via the glass sheet 21. Disposed upon the glass sheet 21 by suitable etching techniques are columns 23 and rows 25. The rows are made from an extremely thin layer of indium-tin-oxide (ITO) while the columns are made from thin layers of aluminum. These patterns are provided in extremely thin layers and essentially constitute an X Y matrix. The layers of ITO are relatively thin, being approximately 300 Angstroms in thickness. In any event, the grid or columns and the rows or cathodes are spaced from one another and insulated from one another by means of an insulating layer 22.

While the grids and cathodes have been specified in terms of rows and columns, it is immediately apparent that the terms can be interchanged as desired. In any event, each of the grid and cathode intersections are associated with a pigment well 24. These wells contain the electrophoretic solution which is in the cavity 20. The columns and rows are separated from a back electrode 26 or anode plate which is also fabricated on a sheet of glass 27 and constitutes a thin layer of ITO. The anode electrode is essentially an extremely thin planar layer of ITO deposited upon a sheet of glass, as can be seen in many of the above-cited references. The spacers such as 32 and 33 can be implemented in many different ways and essentially serve to mechanically separate the display cell or panel 10.

Shown positioned between the grid cathode structure and the anode 26 is a mesh electrode 30. The mesh electrode 30 is fabricated from a thin sheet of stainless steel having a plurality of apertures therein to create a mesh or screen like structure. The electrodes of the display are biased by means of the power supply 50. The supply 50 operates similar to that shown in the above cited patent U.S. 4,746,917. As indicated, the anode electrode 26 is a thin layer of ITO which is semi-transparent and highly reflective. The electrode 30 contains a plurality of apertures and due to the mesh like construction will allow light to pass via the apertures. The configuration described employs the anode 26 with the mesh like electrode 30. This configuration permits greater control of the pigment particles due to the various ratios of the potential applied to the electrode 30 as compared to that applied to the anode 26.

An extremely important aspect of the electrophoretic display which will enhance operation even further, is the possibility of back lighting the display. As seen in FIG. 1, there is shown a bulb 40 which appears at the back of the display while the viewer's eye 15 is at the front of the display. If the bulb is illuminated then the pattern, which is disposed upon the cathode surface, will stand out due to the fact that the light source 40 will tend to increase the contrast of the display. The electrophoretic solution can be illuminated by means of the light source as 40 thus creating greater contrast and enabling the display to be even clearer.

The configuration, as shown in FIG. 1, may be simply constructed using methods as taught by many of the references cited above. For example, a layer of insulating material is first coated on top of the ITO layer 26 which ITO layer is deposited upon the glass substrate 27. A layer of metal is then coated on the insulating material. This metal layer is patterned by a photolithographic technique to produce a mesh pattern. The insulating material is then plasma etched to produce the wells or apertures which therefore communicate between the mesh and the anode with the mesh being insulated from the anode by means of an insulating layer 41 as shown in FIG. 1.

In order to operate the display of FIG. 1, normal grid and cathode voltages are employed, as indicated

and shown in the above references. The voltage employed on the mesh electrode or the mesh anode is a relatively high voltage designated as for example +HV and this voltage is applied during the hold and write modes of the display. The electrode 26 designated as the anode, is connected to a voltage which is +HV -ΔV. The voltage ΔV is selected to be between 5 and 10% less than the voltage +HV. Thus the mesh 30 is positive relative to the anode 26 and hence the pigment particles stop at the mesh permitting a maximum amount of illumination from the back lighting source 40. It is of course understood that if the anode 26 is completely eliminated, the mesh electrode 30 can be deposited directly on the glass sheet 27 by the above-described methods as should be obvious to those skilled in the art. In this manner a maximum amount of light will pass through the apertures created in the mesh.

In operation of the display the pigment particles contained in the electrophoretic solution 20 are brought forward towards the viewing surface in order to fill the wells formed between the rows and columns. Once a well such as well 24 is filled, the voltage on the rows, columns, and anode is then set such that the wells remain filled but pigment spaced between the rear cover and the columns are swept unto the mesh (30) and anode (26). The viewing side 21 is the color of the pigment in the wells.

By selectively applying voltages to the rows and columns, the pigment in individual wells 24 (at the intersection of the rows and columns selected) is forced out of the wells exposing the dye solution and making that intersection (pixel) dark. The removal of the pigment from the wells is not instantaneous but requires a period of time which depends upon the dimension of the cell or display, the fluid components, and the various applied voltages. The use of the mesh electrode 30 operates to more rapidly propel the pigment particles due to the increased field provided by the additional mesh electrode and hence affords a more rapid removal of particles from the wells. This is also due to the mesh like construction as the apertures in the mesh electrode enhance the field strength.

Referring to Fig. 2, there is shown a planar plan view of an enlarged representation of an electrophoretic display cell or panel according to Fig. 1.

As seen in Fig. 2, each well 24 is accommodated between an intersection of a column 23 which is insulatively separated from a row layer of ITO 25. The well 24 forms a pixel area which is indicative of an X Y intersection on the ITO display.

The pigment particles of course travel between the cathode and anode. As shown in FIG. 2, the anode may be the mesh-like structure 30 or may constitute a separate mesh structure fabricated directly on the layer of glass as above described or a stainless steel mesh 30 may be interposed between the anode and a cathode grid structure as indicated. As seen in FIG. 2, the mesh contains a plurality of apertures which are for example circular holes. It is immediately understood that the mesh may contain any shaped apertures, such as rectangular, square, triangular and so on. Essentially the apertures are extremely small. The mesh is a hardened stainless steel mesh available from many sources. Each aperture is between 0.254mm to 0.76mm (10 to 30 mils) in diameter with the space between apertures being of the same magnitude, namely 0.254mm to 0.76mm (10 to 30 mils). Preferably the apertures are approximately 0.38mm (15 mils) in diameter with the space between the apertures about 0.38mm to 0.51mm (15 to 20 mils). Hence, as one can ascertain, due to the extremely large number of apertures and due to the spacing between apertures, the hardened stainless steel sheet appears as a total mesh-like structure which is integrally formed and highly conductive. Hence the same can act as an anode electrode or as an intermediate electrode to aid and assist in controlling the pigment particles.

The above-noted mesh structure creates an electrophoretic display having superior operating characteristics over those provided in the prior art.

Claims

1. An electrophoretic display (10) of the type having an XY matrix assembly consisting of a grid of vertically oriented, electrically conductive lines (23) intersected by a grid of horizontally oriented, electrically conductive lines (25) and insulated therefrom, with a semi-transparent anode electrode (26) spaced from said matrix assembly, with an electrophoretic dispersion (20) located between said anode and matrix assembly, and with a voltage source (50) for biasing the matrix assembly and anode electrode, characterised by a mesh like electrode structure (30) located between said matrix assembly and said anode electrode and connected to said voltage source, said voltage source being adapted to always bias said mesh electrode at a greater positive potential than said anode electrode and said matrix assembly.

2. The electrophoretic display according to Claim 1 wherein said anode electrode (26) comprises a thin layer of ITO with said mesh like electrode (30) located between said anode electrode and said matrix and operative when biased to further control electrophoretic particles.

3. The electrophoretic display according to Claim 2 wherein said mesh like electrode (30) is a planar sheet of a conductive material having a plurality of apertures on the surface to form a mesh like

structure.

4. The electrophoretic display according to Claim 3 wherein said conductive material is stainless steel.

5. The electrophoretic display according to Claim 4 wherein said apertures are circular in shape, each having a diameter of between 0.254 - 0.76 mm (10-30 mils) and spaced one from the other between 0.254 - 0.76 mm (10-30 mils).

6. The electrophoretic display according to Claim 1 wherein said anode electrode (26) is deposited on a planar glass member (27).

7. The electrophoretic display according to Claim 1 further including means for applying a higher positive potential to said mesh electrode (30) than said anode electrode (26) to cause pigment particles to migrate to and stop at said mesh electrode.

8. The electrophoretic display according to claim 6 further characterised by a light source (40) located in proximity to said anode electrode to cause light to pass through said anode structure to said matrix structure for illuminating said display.

9. A method of operating an electrophoretic display (10) having a mesh electrode (30) between an anode electrode (26) on a back surface (27) and an XY matrix assembly consisting of a grid of vertically oriented, electrically conductive lines (23) intersected by a grid of horizontally oriented, electrically conductive lines (25) and insulated therefrom, said matrix assembly, said anode electrode and said mesh electrode being connected to a voltage source (50), and said XY matrix defining a pigment well (24) adjacent a viewing surface (21) at each intersection of conductive lines, characterized by the steps of:

applying a potential bias to said anode electrode; and

applying to said mesh electrode a bias of a more positive potential than that applied to said anode electrode and said matrix assembly, to cause pigment particles to propagate to and stop at said mesh electrode.

10. The method according to Claim 9, further characterized by the step of applying a bias, before said anode and mesh bias applying steps, to said XY matrix until selected pigment wells are filled, wherein the selected wells remain filled but pigment spaced between the rear cover and columns are swept on the mesh electrode and anode electrode when the biases are applied to said anode electrode and said mesh electrode.

11. The method according to claim 10 further chacterized by the step of selectively applying voltages to said electrically conductive lines to force pigment from a plurality of said selected wells during said anode electrode and mesh electrode bias applying steps, wherein said mesh electrode operates to more rapidly propel the pigment particles from said plurality of selected wells.

Patentansprüche

1. Elektrophoretische Anzeigevorrichtung (10) des Typs mit einer XY-Matrixanordnung, die aus einem Gitter aus vertikal orientierten, elektrisch leitenden Leitungen (23) besteht, die von einem Gitter aus horizontal orientierten, elektrisch leitenden Leitungen (25) geschnitten werden und dagegen isoliert sind, mit einer von der Matrixanordnung beabstandeten, halbtransparenten Anodenelektrode (26), mit einer elektrophoretischen Dispersion (20), die sich zwischen der Anode und der Matrixanordnung befindet, sowie mit einer Spannungsquelle (50) zum Vorspannen der Matrixanordnung und der Anodenelektrode, gekennzeichnet durch eine netzartige Elektrodenstruktur (30), die sich zwischen der Matrixanordnung und der Anodenelektrode befindet und mit der Spannungsquelle verbunden ist, wobei die Spannungsquelle dazu geeignet ist, die Netzelektrode stets auf einem größeren positiven Potential als die Anodenelektrode und die Matrixanordnung vorzuspannen.

2. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die Anodenelektrode (26) eine dünne Schicht aus ITO aufweist, wobei sich die netzartige Elektrode (30) zwischen der Anodenelektrode und der Matrix befindet und bei Vorspannung wirksam ist, um elektrophoretische Teilchen weiter zu steuern.

3. Elektrophoretische Anzeigevorrichtung nach Anspruch 2, bei welcher die netzartige Elektrode (30) eine planare Tafel aus einem leitenden Material mit einer Vielzahl von Öffnungen an der Oberfläche zur Bildung einer netzartigen Struktur ist.

4. Elektrophoretische Anzeigevorrichtung nach Anspruch 3, bei welcher das leitende Material Edelstahl ist.

5. Elektrophoretische Anzeigevorrichtung nach Anspruch 4, bei welcher die Öffnungen kreisförmig sind, wobei jede einen Durchmesser zwischen

0,254 - 0,76 mm aufweist, und zwischen 0,254 - 76 mm voneinander beabstandet sind.

6. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die Anodenelektrode (26) auf einem planaren Glaselement (27) aufgebracht ist.

7. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, die ferner Mittel zum Anlegen eines höheren positiven Potentials an die Netzelektrode (30) als an die Anodenelektrode (26) aufweist, um Pigmentteilchen zu veranlassen, zu der Netzelektrode zu wandern und dort anzuhalten.

8. Elektophoretische Anzeigevorrichtung nach Anspruch 6, ferner gekennzeichnet durch eine Lichtquelle (40), die sich in der Nähe der Anodenelektrode befindet, um den Durchgang von Licht durch die Anodenstruktur zu der Matrixstruktur zur Beleuchtung der Anzeigevorrichtung zu veranlassen.

9. Verfahren zum Betrieb einer elektrophoretischen Anzeigevorrichtung (10) mit einer Netzelektrode (30) zwischen einer Anodenelektrode (26) an einer Rücktfläche (27) und einer XY-Matrix-Einheit, die aus einem Gitter aus vertikal orientierten, elektrisch leitenden Leitungen (23) besteht, die von einem Gitter aus horizontal orientierten, elektrisch leitenden Leitungen (25) besteht, die dagegen isoliert sind, wobei die Matrixanordnung, die Anodenelektrode und die Netzelektrode mit einer Spannungsquelle (50) verbunden sind und die XY-Matrix an jedem Schnittpunkt von leitenden Leitungen eine Pigmentwanne (24) angrenzend an eine Beobachtungsfläche (21) bildet, gekennzeichnet durch die folgenden Schritte:

Anlegen einer Potentialvorspannung an die Anodenelektrode; und

Anlegen einer Vorspannung mit einem positiveren Potential als dem an die Anodenelektrode und die Matrixanordnung angelegten an die Netzelektrode, um Pigmentteilchen zu veranlassen, sich zu der Netzelektrode fortzupflanzen und dort anzuhalten.

10. Verfahren nach Anspruch 9, ferner gekennzeichnet durch den Schritt des Anlegens einer Vorspannung an die XY-Matrix vor den Schritten des Anlegens der Anoden- und Netzvorspannung, bis ausgewählte Pigmentwannen gefüllt sind, wobei die ausgewählten Wannen gefüllt bleiben, aber zwischen der Rückabdeckung und den Spalten beabstandete Pigmente an die Netzelektrode und die Anodenelektrode geschwemmt werden, wenn die Vorspannungen an die Anodenelektrode und die Netzelektrode angelegt werden.

11. Verfahren nach Anspruch 10, ferner gekennzeichnet durch den Schritt des selektiven Anlegens von Spannungen an die elektrisch leitenden Leitungen, um während der Schritte des Anlegens einer Anodenelektroden- und Netzelektrodenvorspannung Pigmente aus einer Vielzahl von ausgewählten Wannen zu drängen, wobei die Netzelektrode so arbeitet, um die Pigmentteilchen schneller aus der Vielzahl von ausgewählten Wannen zu treiben.

Revendications

1. Afficheur électrophorétique (10) du type pourvu d'un assemblage en matrice X Y consistant en une grille de lignes électriquement conductrices (23) orientée verticalement, coupée par une grille de lignes électriquement conductrices (25) orientée horizontalement et isolée par rapport à celle-ci, avec une électrode d'anode semi-transparente (26) espacée par rapport audit assemblage en matrice, avec une solution électrophorétique (20) située entre lesdites anode et assemblage en matrice, et avec une source de tension (50) destinée à polariser l'assemblage en matrice et l'électrode d'anode, caractérisé par une structure d'électrode en forme de treillis (30) située entre ledit assemblage en matrice et ladite électrode d'anode et reliée à ladite source de tension, ladite source de tension étant adaptée de façon à polariser en permanence ladite électrode en treillis à un potentiel positif supérieur à celui de ladite électrode d'anode et dudit assemblage en matrice.

2. Afficheur électrophorétique selon la revendication 1, dans lequel ladite électrode d'anode (26) comprend une fine couche d'ITO, ladite électrode en forme de treillis (30) étant située entre ladite électrode d'anode et ladite matrice et agissant, lorsqu'elle est polarisée, de façon à aussi commander les particules électrophorétiques.

3. Afficheur électrophorétique selon la revendication 2, dans lequel ladite électrode en forme de treillis (30) est une feuille plane d'un matériau conducteur disposant d'une pluralité d'ouvertures sur la surface de façon à former une structure en forme de treillis.

4. Afficheur électrophorétique selon la revendication 3, dans lequel ledit matériau conducteur est de l'acier inoxydable.

5. Afficheur électrophorétique selon la revendication 4, dans lequel lesdites ouvertures sont de

forme circulaire, chacune ayant un diamètre situé entre 0,254 et 0,76 mm (10 à 30 mils) et sont espacées l'une de l'autre de 0,254 à 0,76 mm (10 à 30 mils) environ.

6. Afficheur électrophorétique selon la revendication 1, dans lequel ladite électrode d'anode (26) est déposée sur un élément en verre plan (27).

7. Afficheur électrophorétique selon la revendication 1, comprenant en outre un moyen pour appliquer un potentiel positif plus élevé sur ladite électrode en treillis (30) que celui de ladite électrode d'anode (26) de façon à provoquer la migration des particules de pigment vers ladite électrode en treillis et leur arrêt sur celle-ci.

8. Afficheur électrophorétique selon la revendication 6, caractérisé en outre par une source de lumière (40) située à proximité de ladite électrode d'anode de façon à faire passer la lumière à travers ladite structure d'anode vers ladite structure en matrice afin d'éclairer ledit afficheur.

9. Procédé de commande d'un afficheur électrophorétique (10) pourvu d'une électrode en treillis (30) disposée entre une électrode d'anode (26) sur une face arrière (27) et un assemblage en matrice X Y consistant en une grille de lignes électriquement conductrices (23) orientée verticalement, coupée par une grille constituée de lignes électriquement conductrices (25) orientée horizontalement et isolée par rapport à celle-ci, ledit assemblage en matrice, ladite électrode d'anode et ladite électrode en treillis étant reliés à une source de tension (50), et ladite matrice X Y définissant un puits de pigment (24) adjacent à une surface de visualisation (21) à chaque intersection des lignes conductrices, caractérisé par les étapes de :

application d'une tension de polarisation sur ladite électrode d'anode ; et

application sur ladite électrode en treillis d'une polarisation avec une tension positive supérieure à celle appliquée sur ladite électrode d'anode et sur ledit assemblage en matrice, de façon à provoquer la propagation des particules de pigment vers ladite électrode en treillis et leur arrêt sur celle-ci.

10. Procédé selon la revendication 9, caractérisé en outre par l'étape d'application d'une polarisation, avant lesdites étapes d'application d'une polarisation sur l'anode et le treillis, sur ladite matrice X Y jusqu'à ce que les puits de pigment sélectionnés soient remplis, dans lequel les puits sélectionnés restent remplis mais les pigments isolés entre le couvercle arrière et les colonnes sont balayés sur l'électrode en treillis et l'électrode d'anode lorsque les polarisations sont appliquées sur ladite électrode d'anode et sur ladite électrode en treillis.

11. Procédé selon la revendication 10, caractérisé en outre par les étapes d'application de façon sélective de tensions sur lesdites lignes électriquement conductrices de façon à forcer les pigments issus d'une pluralité desdits puits sélectionnés pendant lesdites étapes d'application d'une polarisation sur les électrode d'anode et électrode en treillis, dans lequel ladite électrode en treillis agit de façon à propulser plus rapidement les particules de pigment issues de ladite pluralité de puits sélectionnée.

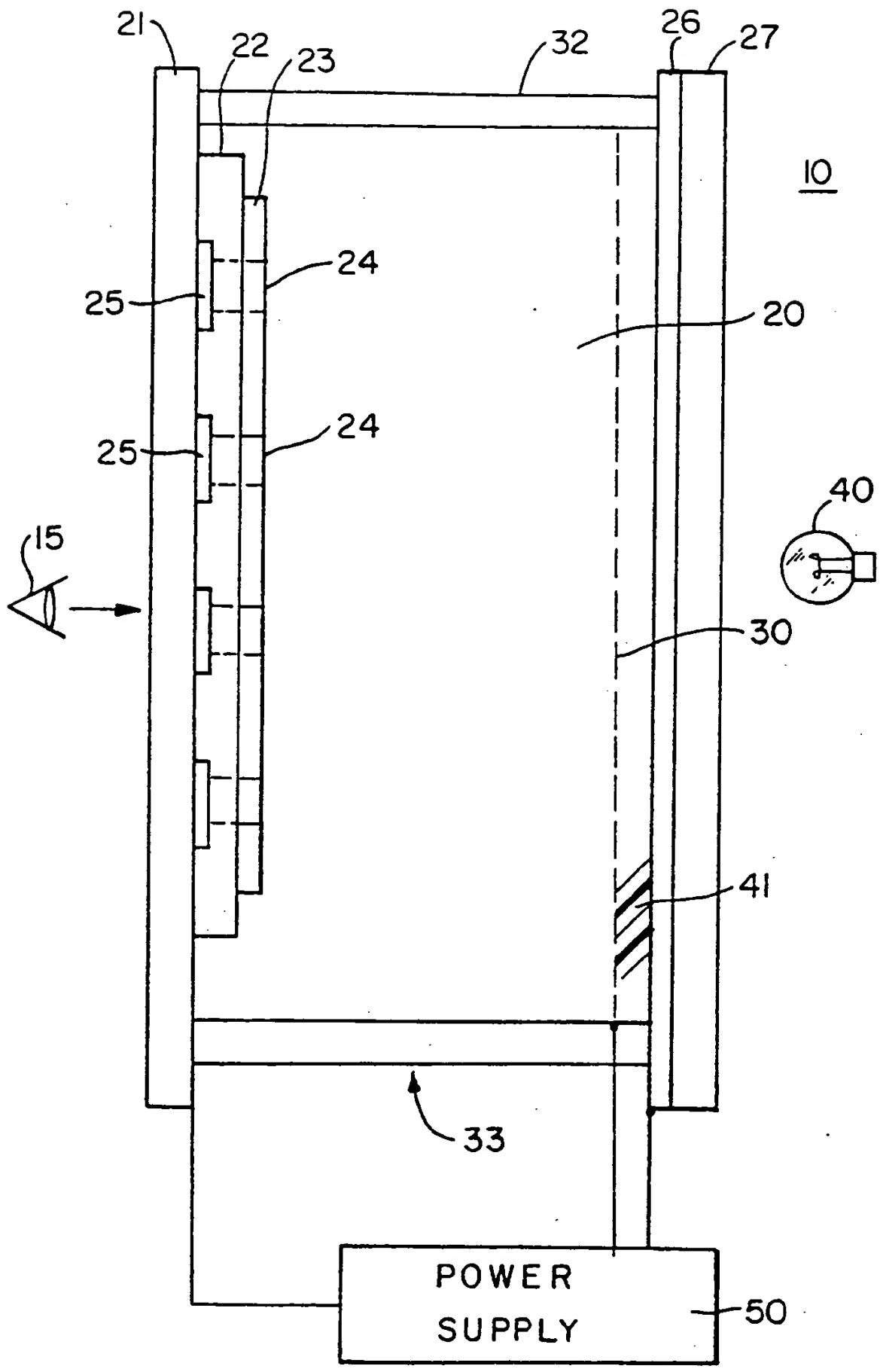

FIG. 1

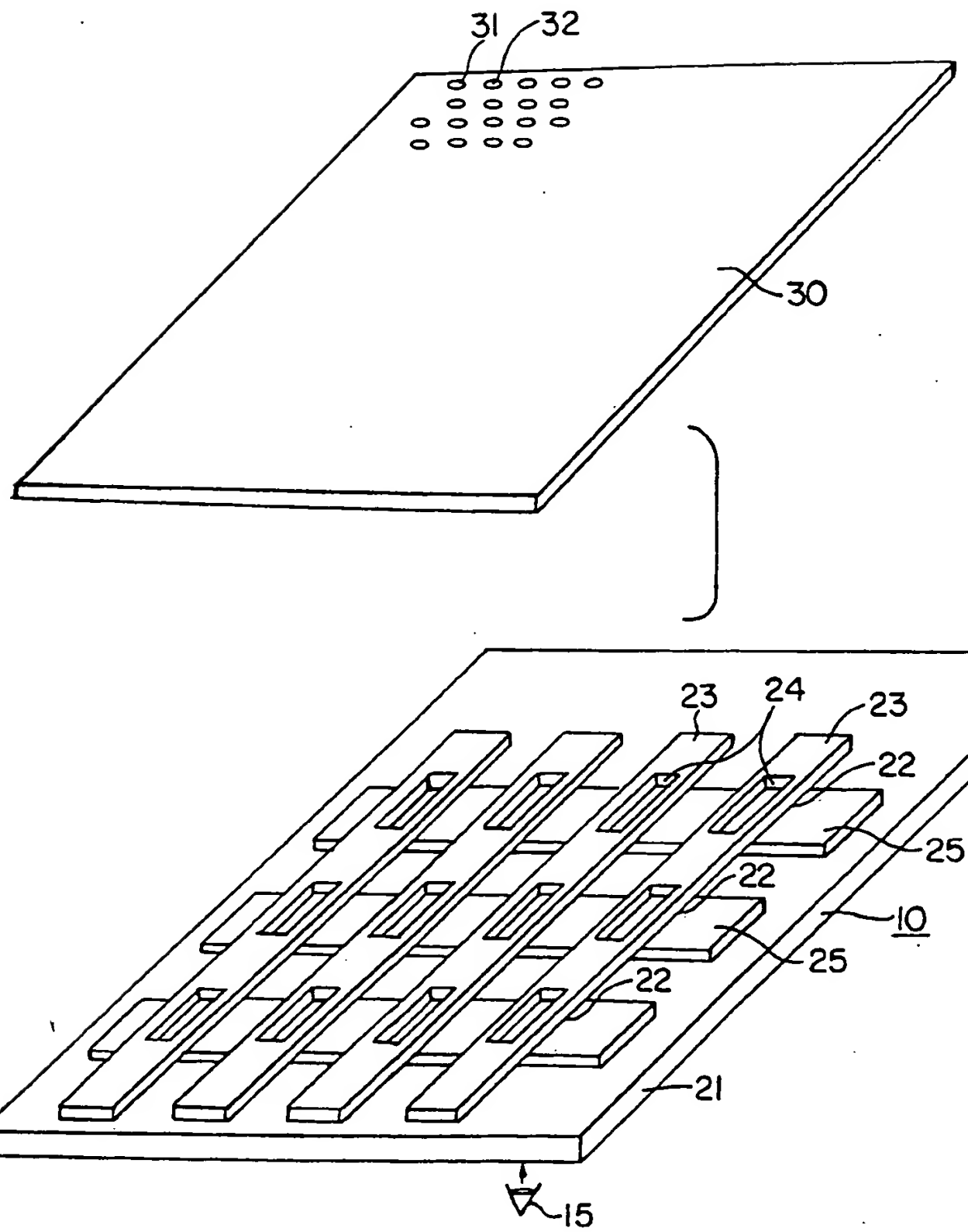

FIG. 2

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(54) Semitransparent electrophoretic information display (EPID) employing mesh like electrodes.

(57) An electrophoretic display (10) includes a plurality of intersecting grid (23) and cathode (25) lines which are spaced one from the other by means of an insulating material (22). The grid and cathode lines are associated with an anode electrode (26) which constitutes a planar glass plate (27) having deposited thereon a thin layer of ITO or a similar metal. Interposed between the cathode and grid structure (22-25) and the anode plate (26) is a mesh electrode (30) which is relatively of the same size as the anode plate. Control voltages are applied to the mesh structure (30) and the anode electrode (26) to further control particle propagation. The conventional anode structure may be entirely replaced with the mesh-like structure to provide an electrophoretic display which can be optimumly illuminated by back lighting (40).

EP 0 570 995 A1

BACKGROUND OF THE INVENTION

This invention relates to electrophoretic information displays (EPID) in general and more particularly to an EPID display employing a mesh like electrode.

The prior art is replete with a number of various patents and articles concerning electrophoretic displays. Such electrophoretic displays have been widely described and disclosed in the prior art, and essentially the assignee herein, namely --Copytele, Inc. of Huntington Station, New York, has recently developed an electrophoretic display which has an image area of approximately 11 x 8 1/2 inches and is designed to be used either as a separate display or to be combined with other displays. The company has the ability to combine as many as four such displays to create image areas as large as approximately 22 x 17 inches.

The information on such displays can be changed either locally or remotely and can be viewed at an angle of nearly 180°. Such displays have extremely high resolution and can accommodate over 160,000 pixels within an image area of approximately 2.8 inches diagonally. In regard to such displays, reference is made to U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS to Frank J. DiSanto and Denis A. Krusos and assigned to Copytele, Inc., the assignee herein.

In that patent there is described an electrophoretic display panel which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line pattern is filled with an electrophoretic dispersion containing chargeable pigment particles.

When a voltage is impressed on the X and Y lines, pigment particles which are located in wells or depressions between the X and Y pattern are caused to migrate towards the conductive plate and are deposited on the plate in accordance with the bias supplied to the X and Y conductors.

There is described in that patent an electrophoretic dispersion suitable for operation with the display as well as techniques for fabricating the display. Hence, in this manner the displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution and relatively low power. As indicated, the above-noted patent and others include information concerning the fabrication, operation and resolution of such displays.

See also U.S. Patent 4,772,820 entitled "Monolithic Flat Panel Display Apparatus" issued on September 20, 1988 to Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows an electrophoretic display as well as methods for fabrication and operating such a display.

See also U.S. Patent 4,742,345 entitled "Electrophoretic Display Panel Apparatus and Methods Therefor" by Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows such a display having improved alignment and contrast characteristics and structure and methods for aligning and operating such a display.

See also U.S. Patent 4,746,917 entitled "Methods And Apparatus For Operating An Electrophoretic Display Between A Display And A Non-Display Mode" issued on May 24, 1988 to Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows and describes a power supply circuit for operating such a display between a display and a non-display mode.

As one can ascertain from the prior art, the electrophoretic display has been thoroughly investigated and essentially it is a continuing object to provide more reliable operation as well as to provide displays which permit greater control of the image producing pigment particles as propagating within the display.

The electrophoretic effect is associated with working fluids which includes a dispersion of electrophoretic particles. These particles may be fabricated from an opaque dielectric material or a pigment which particles are suspended in a colored non-conducting suspension medium. The particles preferably are uniformly distributed throughout the suspension medium and the contrast between the particles and the suspension medium is the mechanism which enables one to formulate an image.

When the composite material is subjected to an electric field, the particles are caused to move electrophoretically in the direction of either the cathode or the anode. These particles are deposited upon the respective structure to cause that structure to assume the color of the particle which, for example, may be grey, white or some other color depending upon the pigment utilized. Hence, as one can ascertain, by selectively moving the particles one can produce images based on the migration and orientation of the particles with respect to a charged surface. As indicated, this effect is well known as for example ascertained by the above-noted prior art and many of the references cited against such prior art.

As one will immediately understand, it is a major object in all such displays to produce a reliable display as well as to provide a uniform and rapid movement of the particles. In prior art displays, extreme difficulty was experienced when attempting to move the particles at high speeds and to further control the particles so that a uniform image is displayed. It was a further difficulty to utilize lighting as back lighting with such a display due to the fact that the anode electrode, which is a planar electrode, is not totally transparent but essentially is semi-transparent and hence any attempts to back light the displays of the prior art were difficult to accommodate.

It is an object of the present invention to provide a mesh electrode which mesh electrode provides greater control of the pigment particles and therefore provides a display which is more reliable and easier controlled than those of the prior art.

It is a further object to provide an electrophoretic display having a mesh electrode to enable back lighting of the display and hence overcoming many of the prior art problems.

SUMMARY OF THE INVENTION.

An electrophoretic display of the type having an X-Y matrix of intersecting cathode and grid lines and an anode electrode separated from said matrix, with an electrophoretic dispersion located between said anode electrode and said matrix , characterised by:

an anode electrode being a mesh like structure having a plurality of closely spaced apertures located on the surface thereof and adapted to receive an operating potential to cause pigment particles to migrate to said mesh during display operation.

BRIEF DESCRIPTION OF THE FIGURES.

Fig. 1 is a partial plan view of an electrophoretic display apparatus according to this invention; and

Fig. 2 is a plan view of an electrophoretic display showing certain aspects of the present invention.

DETAILED DESCRIPTION OF THE FIGURES.

Referring to Fig. 1, there is shown a side view of a typical electrophoretic display 10.

The display 10 of Fig. 1 is filled with an electrophoretic solution or dispersion 20 which includes light coloured pigment particles suspended in a dark dye solution. For examples of such solutions and techniques, reference is made to the above-cited U.S. Patent No. 4,655,897.

As seen from Fig. 1, the display contains a front glass sheet or viewing surface 21. The eye of viewer 15 is shown viewing the front of the display via the glass sheet 21. Disposed upon the glass sheet 21 by suitable etching techniques are columns 23 and rows 25. The rows are made from an extremely thin layer of indium-tin-oxide (ITO) while the columns are made from thin layers of aluminum. These patterns are provided in extremely thin layers and essentially constitute an X Y matrix. The layers of ITO are relatively thin, being approximately 300 Angstroms in thickness. In any event, the grid or columns and the rows of cathodes are spaced from one another and insulated from one another by means of an insulating layer 22.

While the grids and cathodes have been specified in terms of rows and columns, it is immediately apparent that the terms can be interchanged as desired. In any event, each of the grid and cathode intersections are associated with a pigment well 24. These wells contain the electrophoretic solution which is in the cavity 20. The columns and rows are separated from a back electrode 26 or anode plate which is also fabricated on a sheet of glass 27 and constitutes a thin layer of ITO. The anode electrode is essentially an extremely thin planar layer of ITO deposited upon a sheet of glass, as can be seen in many of the above-cited references. The spacers such as 32 and 33 can be implemented in many different ways and essentially serve to mechanically separate the display cell or panel 10.

Shown positioned between the grid cathode structure and the anode 26 is a mesh electrode 30. The mesh electrode 30 is fabricated from a thin sheet of stainless steel having a plurality of apertures therein to create a mesh or screen like structure. The electrodes of the display are biased by means of the power supply 50. The supply 50 operates similar to that shown in the above cited Patent U.S. 4,746,917. As indicated, the anode electrode 26 is a thin layer of ITO which is semi-transparent and highly reflective. The electrode 30 contains a plurality of apertures and due to the mesh like construction will allow light to pass via the apertures. The configuration described employs the anode 26 with the mesh like electrode 30. This configuration permits greater control of the pigment particles due to the various ratios of the potential applied to the electrode 30 as compared to that applied to the anode 26.

An extremely important aspect of the electrophoretic display which will enhance operation even further, is the possibility of back lighting the display. As seen in Fig. 1, there is shown a bulb 40 which appears at the back of the display while the viewer's eye 15 is at the front of the display. If the bulb is illuminated then the pattern, which is dis-

posed upon the cathode surface, will stand out due to the fact that the light source 40 will tend to increase the contrast of the display. The electrophoretic solution can be illuminated by means of the light source as 40 thus creating greater contrast and enabling the display to be even clearer.

As one can understand, based on the fact that the display of Fig. 1 includes both the mesh electrode 30 and the anode electrode 26 some pigment stops at the mesh electrode and some pigment continues and stops at the anode electrode. Thus the amount of illumination from the back is somewhat attenuated. In order to avoid this, a display has been constructed which essentially eliminates the thin planar anode electrode. Thus the configuration of the display is as follows. Layers 26 and 27 are both glass or a single sheet of glass with the mesh electrode 30 deposited upon the glass sheet or positioned as shown in Fig. 1, thus entirely eliminating the planar anode electrode but substituting therefor a mesh electrode. Since all the pigment stops at the mesh anode 30 much more back lighting illumination passes through the cell via the mesh structure.

The configuration, as shown in Fig. 1, may be simply constructed using methods as taught by many of the references cited above. For example, a layer of insulating material is first coated on top of the ITO layer 26 which ITO layer is deposited upon the glass substrate 27. A layer of metal is then coated on the insulating material. This metal layer is patterned by a photolithographic technique to produce a mesh pattern. The insulating material is then plasma etched to produce the wells or apertures which therefore communicate between the mesh and the anode with the mesh being insulated from the anode by means of an insulating layer 41 as shown in Fig. 1.

In order to operate the display of Fig. 1, normal grid and cathode voltages are employed, as indicated and shown in the above references. The voltage employed on the mesh electrode or the mesh anode is a relatively high voltage designated as for example +HV and this voltage is applied during the hold and write modes of the display. The electrode 26 designated as the anode, is connected to a voltage which is +HV-$_{\Delta}$V. The voltage $_{\Delta}$V is selected to be between 5 and 10% less than the voltage +HV. Thus the mesh 30 is positive relative to the anode 26 and hence the pigment particles stop at the mesh permitting a maximum amount of illumination from the back lighting source 40. It is of course understood that if the anode 26 is completely eliminated, the mesh electrode 30 can be deposited directly on the glass sheet 27 by the above-described methods as should be obvious to those skilled in the art. In this manner a maximum amount of light will pass through the apertures created in the mesh.

In operation of the display the pigment particles contained in the electrophoretic solution 20 are brought forward towards the viewing surface in order to fill the wells formed between the rows and columns. Once a well such as well 24 is filled, the voltage on the rows, columns, and anode is then set such that the wells remain filled but pigment spaced between the rear cover and the columns are swept unto the mesh (30) and anode (26). The viewing side 21 is the color of the pigment in the wells.

By selectively applying voltages to the rows and columns, the pigment in individual wells 24 (at the intersection of the rows and columns selected) is forced out of the wells exposing the dye solution and making that intersection (pixel) dark. The removal of the pigment from the wells is not instantaneous but requires a period of time which depends upon the dimension of the cell or display, the fluid components, and the various applied voltages. The use of the mesh electrode 30 operates to more rapidly propel the pigment particles due to the increased field provided by the additional mesh electrode and hence affords a more rapid removal of particles from the wells. This is also due to the mesh like construction as the apertures in the mesh electrode enhance the field strength.

Referring to Fig. 2, there is shown a planar plan view of an enlarged representation of an electrophoretic display cell or panel according to Fig. 1.

As seen in Fig. 2, each well 24 is accommodated between an intersection of a column 23 which is insulatively separated from a row layer of ITO 25. The well 24 forms a pixel area which is indicative of an X Y intersection on the ITO display.

The pigment particles of course travel between the cathode and anode. As shown in Fig. 2, the anode may be the mesh-like structure 30 or may constitute a separate mesh structure fabricated directly on the layer of glass as above described or a stainless steel mesh 30 may be interposed between the anode and a cathode grid structure as indicated. As seen in Fig. 2, the mesh contains a plurality of apertures which are for example circular holes. It is immediately understood that the mesh may contain any shaped apertures, such as rectangular, square, triangular and so on. Essentially the apertures are extremely small. The mesh is a hardened stainless steel mesh available from many sources. Each aperture is between .0254 mm to .076 mm (10 to 30 mils) in diameter with the space between apertures being of the same magnitude, namely .0254 mm to .076 mm (10 to 30 mils). Preferably the apertures are approximately .038 mm (15 mils) in diameter with the space between the apertures about .038 mm to .051 mm (15 to 20 mils). Hence, as one can ascertain, due to the

extremely large number of apertures and due to the spacing between apertures, the hardened stainless steel sheet appears as a total mesh-like structure which is integrally formed and highly conductive. Hence the same can act as an anode electrode or as an intermediate electrode to aid and assist in controlling the pigment particles.

As one can ascertain again from Fig. 1, due to the extremely transparent nature of the mesh-like structure, one can therefore direct light from a source 40 directly through the mesh when an additional ITO coated anode as 26 is not being employed. The above-noted mesh structure creates an electrophoretic display having superior operating characteristics over those provided in the prior art.

Claims

1. An electrophoretic display of the type having an X-Y matrix of intersecting cathode and grid lines and an anode electrode separated from said matrix, with an electrophoretic dispersion located between said anode electrode and said matrix, characterised by:

   an anode electrode being a mesh like structure having a plurality of closely spaced apertures located on the surface thereof and adapted to receive an operating potential to cause pigment particles to migrate to said mesh during display operation.

2. The apparatus according to claim 1, wherein said anode electrode is a conductive mesh like structure deposited upon a glass layer and separated therefrom by an insulator mesh layer.

3. The apparatus according to claim 2, wherein said mesh like structure is a planar sheet of stainless steel having a plurality of closely spaced apertures on the surface thereof.

4. The apparatus according to claim 1, further including a second anode electrode insulated from said mesh like structure and said second anode electrode being a thin layer of a conductive material deposited on a layer of glass.

5. The apparatus according to claim 4, wherein said thin layer of conductive material is ITO.

6. The apparatus according to claim 3, wherein said apertures as distributed over the entire surface of said sheet are between .0254 mm - .076 mm in diameter and separated one from the other by between .0254 mm - .076 mm.

7. The apparatus according to claim 6, wherein said apertures are circular in shape.

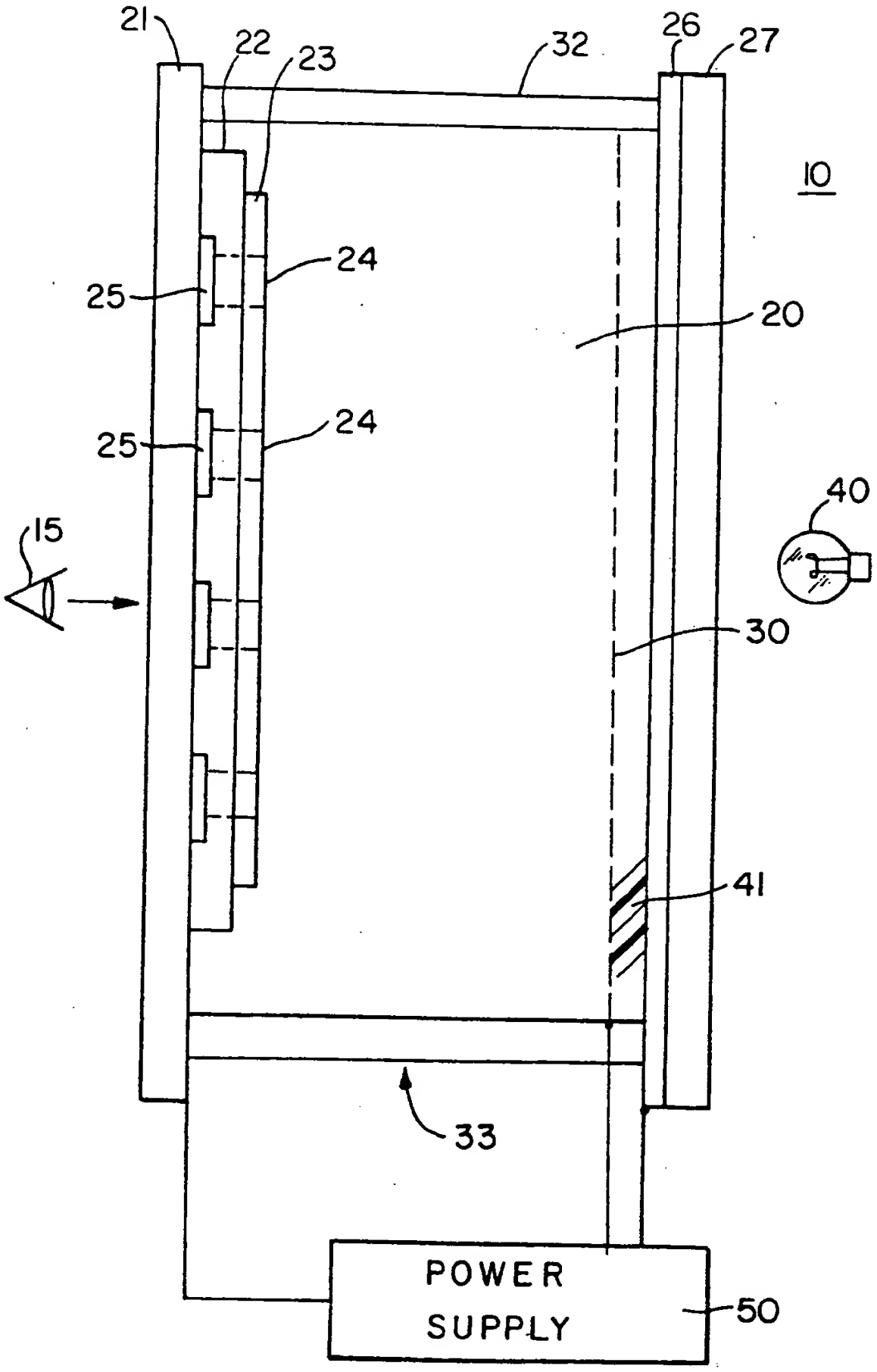

FIG. 1

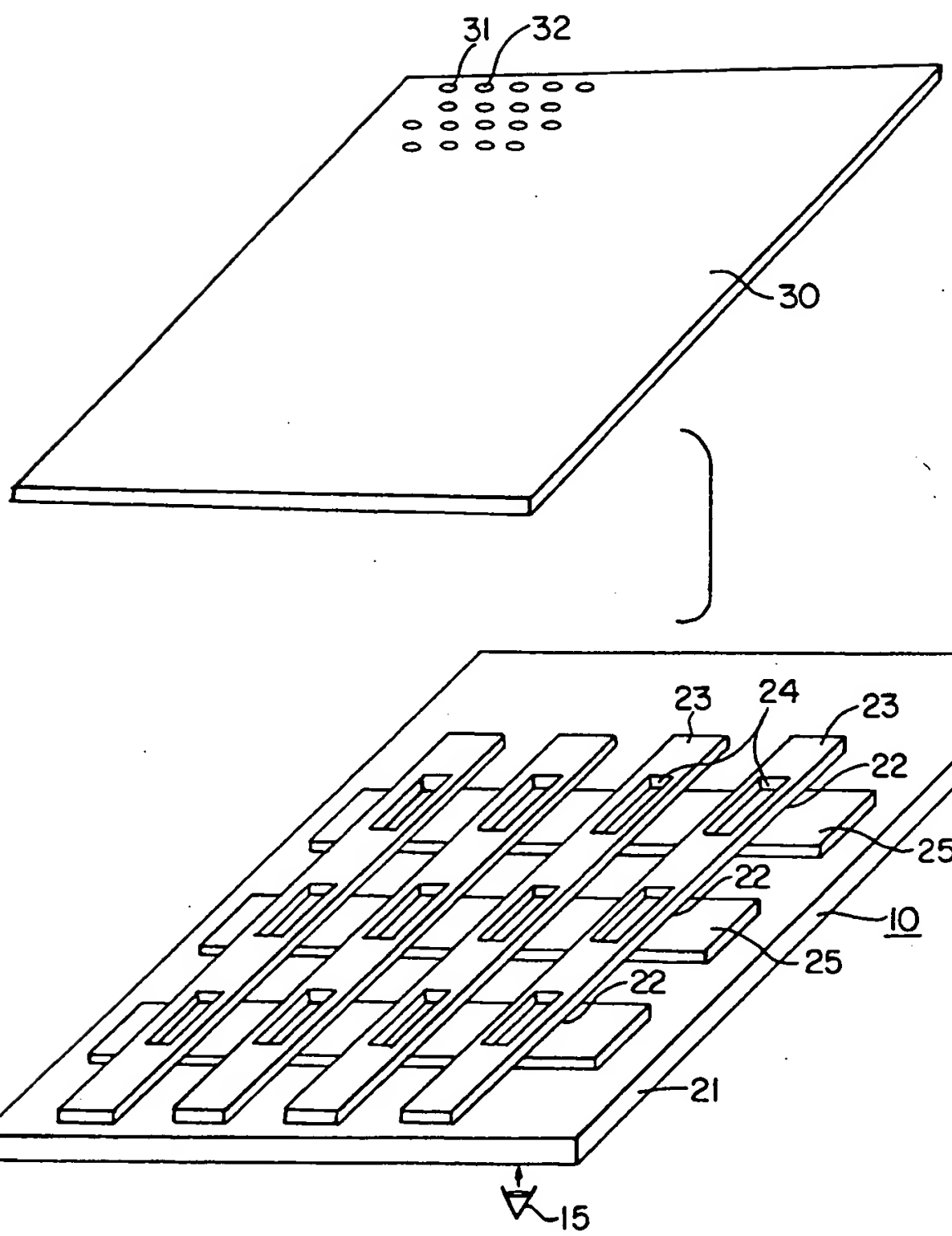

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 11 2534

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 071 430 (LIEBERT) * column 2, line 50 - column 3, line 10; figure *	1,2,4	G02F1/167
A	EP-A-0 186 922 (PHILIPS) * page 4, paragraph 3 - page 6, paragraph 1; figures 1,3 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 SEPTEMBER 1993	WONGEL H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

(19) Europäisches Patentamt
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(11) EP 0 570 995 B1

B14

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(54) Semitransparent electrophoretic information display (EPID) employing mesh like electrodes

Halbtransparente elektrophoretische Anzeigevorrichtung mit netzartigen Elektroden

Afficheur électrophorétique semi-transparent avec des électrodes en forme de treillis

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

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(62) Application number of earlier application in accordance with Art. 76 EPC: **90303210.0**

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(56) References cited:
EP-A- 0 186 922
US-A- 4 071 430

EP 0 570 995 B1

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Description

BACKGROUND OF THE INVENTION

This invention relates to electrophoretic information displays (EPID) in general and more particularly to an EPID display employing a mesh like electrode.

The prior art is replete with a number of various patents and articles concerning electrophoretic displays. Such electrophoretic displays have been widely described and disclosed in the prior art, and essentially the assignee herein, namely --Copytele, Inc. of Huntington Station, New York, has recently developed an electrophoretic display which has an image area of approximately 28 x 21.6 cm (11 x 8 1/2 inches) and is designed to be used either as a separate display or to be combined with other displays. The company has the ability to combine as many as four such displays to create image areas as large as approximately 56 x 43.2 cm (22 x 17 inches).

The information on such displays can be changed either locally or remotely and can be viewed at an angle of nearly 180°. Such displays have extremely high resolution and can accommodate over 160,000 pixels within an image area of approximately 7,1 cm (2.8 inches) diagonally. In regard to such displays, reference is made to U.S. 4,655,897 issued on April 7, 1987 entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS to Frank J. DiSanto and Denis A. Krusos and assigned to Copytele, Inc., the assignee herein.

In that patent there is described an electrophoretic display panel which includes a planar transparent member having disposed on a surface a plurality of vertical conductive lines to form a grid of lines in the Y direction. On top of the grid of vertical lines there is disposed a plurality of horizontal lines which are positioned above the vertical lines and insulated therefrom by a thin insulating layer at each of the intersection points. Spaced above the horizontal and vertical line pattern is a conductive plate. The space between the conductive plate and the X and Y line pattern is filled with an electrophoretic dispersion containing chargeable pigment particles.

When a voltage is impressed on the X and Y lines, pigment particles which are located in wells or depressions between the X and Y pattern are caused to migrate towards the conductive plate and are deposited on the plate in accordance with the bias supplied to the X and Y conductors.

There is described in that patent an electrophoretic dispersion suitable for operation with the display as well as techniques for fabricating the display. Hence, in this manner the displays can be fabricated to contain large effective display surfaces while being relatively thin and which are capable of high resolution and relatively low power. As indicated, the above-noted patent and others include information concerning the fabrication, operation and resolution of such displays.

See also U.S. Patent 4,772,820 entitled "Monolithic Flat Panel Display Apparatus" issued on September 20, 1988 to Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows an electrophoretic display as well as methods for fabrication and operating such a display.

See also U.S. Patent 4,742,345 entitled "Electrophoretic Display Panel Apparatus and Methods Therefor" by Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows such a display having improved alignment and contrast characteristics and structure and methods for aligning and operating such a display.

See also U.S. Patent 4,746,917 entitled "Methods And Apparatus For Operating An Electrophoretic Display Between A Display And A Non-Display Mode" issued on May 24, 1988 to Frank J. DiSanto et al., and assigned to the assignee herein. This patent shows and describes a power supply circuit for operating such a display between a display and a non-display mode.

As one can ascertain from the prior art, the electrophoretic display has been thoroughly investigated and essentially it is a continuing object to provide more reliable operation as well as to provide displays which permit greater control of the image producing pigment particles as propagating within the display.

The electrophoretic effect is associated with working fluids which includes a dispersion of electrophoretic particles. These particles may be fabricated from an opaque dielectric material or a pigment which particles are suspended in a colored non-conducting suspension medium. The particles preferably are uniformly distributed throughout the suspension medium and the contrast between the particles and the suspension medium is the mechanism which enables one to formulate an image.

When the composite material is subjected to an electric field, the particles are caused to move electrophoretically in the direction of either the cathode or the anode. These particles are deposited upon the respective structure to cause that structure to assume the color of the particle which, for example, may be grey, white or some other color depending upon the pigment utilized. Hence, as one can ascertain, by selectively moving the particles one can produce images based on the migration and orientation of the particles with respect to a charged surface. As indicated, this effect is well known as for example ascertained by the above-noted prior art and many of the references cited against such prior art.

As one will immediately understand, it is a major object in all such displays to produce a reliable display as well as to provide a uniform and rapid movement of the particles. In prior art displays, extreme difficulty was experienced when attempting to move the particles at high speeds and to further control the particles so that a uniform image is displayed. It was a further difficulty to utilize lighting as back lighting with such a display due to the fact that the anode electrode, which is a planar elec-

trode, is not totally transparent but essentially is semi-transparent and hence any attempts to back light the displays of the prior art were difficult to accommodate.

It is an object of the present invention to provide a mesh electrode which mesh electrode provides greater control of the pigment particles and therefore provides a display which is more reliable and easier controlled than those of the prior art.

It is a further object to provide an electrophoretic display having a mesh electrode to enable back lighting of the display and hence overcoming many of the prior art problems.

SUMMARY OF THE INVENTION.

An electrophoretic display of the type having an X-Y matrix of intersecting cathode and grid lines and an anode electrode separated from said matrix, with an electrophoretic dispersion located between said anode electrode and said matrix , characterised by:

said anode electrode being a mesh like structure having a plurality of closely spaced apertures located in the surface thereof and adapted to receive an operating potential to cause pigment particles to migrate to said mesh during display operation.

BRIEF DESCRIPTION OF THE FIGURES.

Fig. 1 is a partial plan view of an electrophoretic display apparatus according to this invention; and

Fig. 2 is a plan view of an electrophoretic display showing certain aspects of the present invention.

DETAILED DESCRIPTION OF THE FIGURES.

Referring to Fig. 1, there is shown a side view of a typical electrophoretic display 10.

The display 10 of Fig. 1 is filled with an electrophoretic solution or dispersion 20 which includes light coloured pigment particles suspended in a dark dye solution. For examples of such solutions and techniques, reference is made to the above-cited U.S. Patent No. 4,655,897.

As seen from Fig. 1, the display contains a front glass sheet or viewing surface 21. The eye of viewer 15 is shown viewing the front of the display via the glass sheet 21. Disposed upon the glass sheet 21 by suitable etching techniques are columns 23 and rows 25. The rows are made from an extremely thin layer of indium-tin-oxide (ITO) while the columns are made from thin layers of aluminum. These patterns are provided in extremely thin layers and essentially constitute an X Y matrix. The layers of ITO are relatively thin, being approximately 300 Angstroms in thickness. In any event, the grid or columns and the rows of cathodes are spaced from one another and insulated from one another by means of an insulating layer 22.

While the grids and cathodes have been specified in terms of rows and columns, it is immediately apparent that the terms can be interchanged as desired. In any event, each of the grid and cathode intersections are associated with a pigment well 24. These wells contain the electrophoretic solution which is in the cavity 20. The columns and rows are separated from a back electrode 26 or anode plate which is also fabricated on a sheet of glass 27 and constitutes a thin layer of ITO. The anode electrode is essentially an extremely thin planar layer of ITO deposited upon a sheet of glass, as can be seen in many of the above-cited references. The spacers such as 32 and 33 can be implemented in many different ways and essentially serve to mechanically separate the display cell or panel 10.

Shown positioned between the grid cathode structure and the anode 26 is a mesh electrode 30. The mesh electrode 30 is fabricated from a thin sheet of stainless steel having a plurality of apertures therein to create a mesh or screen like structure. The electrodes of the display are biased by means of the power supply 50. The supply 50 operates similar to that shown in the above cited Patent U.S. 4,746,917. As indicated, the anode electrode 26 is a thin layer of ITO which is semi-transparent and highly reflective. The electrode 30 contains a plurality of apertures and due to the mesh like construction will allow light to pass via the apertures. The configuration described employs the anode 26 with the mesh like electrode 30. This configuration permits greater control of the pigment particles due to the various ratios of the potential applied to the electrode 30 as compared to that applied to the anode 26.

An extremely important aspect of the electrophoretic display which will enhance operation even further, is the possibility of back lighting the display. As seen in Fig. 1, there is shown a bulb 40 which appears at the back of the display while the viewer's eye 15 is at the front of the display. If the bulb is illuminated then the pattern, which is disposed upon the cathode surface, will stand out due to the fact that the light source 40 will tend to increase the contrast of the display. The electrophoretic solution can be illuminated by means of the light source as 40 thus creating greater contrast and enabling the display to be even clearer.

As one can understand, based on the fact that the display of Fig. 1 includes both the mesh electrode 30 and the anode electrode 26 some pigment stops at the mesh electrode and some pigment continues and stops at the anode electrode. Thus the amount of illumination from the back is somewhat attenuated. In order to avoid this, a display has been constructed which essentially eliminates the thin planar anode electrode. Thus the configuration of the display is as follows. Layers 26 and 27 are both glass or a single sheet of glass with the mesh electrode 30 deposited upon the glass sheet or positioned as shown in Fig. 1, thus entirely eliminating the planar anode electrode but substituting therefor a mesh electrode. Since all the pigment stops at the mesh anode 30 much more back lighting illumination passes

through the cell via the mesh structure.

The configuration, as shown in Fig. 1, may be simply constructed using methods as taught by many of the references cited above. For example, a layer of insulating material is first coated on top of the ITO layer 26 which ITO layer is deposited upon the glass substrate 27. A layer of metal is then coated on the insulating material. This metal layer is patterned by a photolithographic technique to produce a mesh pattern. The insulating material is then plasma etched to produce the wells or apertures which therefore communicate between the mesh and the anode with the mesh being insulated from the anode by means of an insulating layer 41 as shown in Fig. 1.

In order to operate the display of Fig. 1, normal grid and cathode voltages are employed, as indicated and shown in the above references. The voltage employed on the mesh electrode or the mesh anode is a relatively high voltage designated as for example +HV and this voltage is applied during the hold and write modes of the display. The electrode 26 designated as the anode, is connected to a voltage which is $+HV-_{\blacktriangle}V$. The voltage $_{\blacktriangle}V$ is selected to be between 5 and 10% less than the voltage +HV. Thus the mesh 30 is positive relative to the anode 26 and hence the pigment particles stop at the mesh permitting a maximum amount of illumination from the back lighting source 40. It is of course understood that if the anode 26 is completely eliminated, the mesh electrode 30 can be deposited directly on the glass sheet 27 by the above-described methods as should be obvious to those skilled in the art. In this manner a maximum amount of light will pass through the apertures created in the mesh.

In operation of the display the pigment particles contained in the electrophoretic solution 20 are brought forward towards the viewing surface in order to fill the wells formed between the rows and columns. Once a well such as well 24 is filled, the voltage on the rows, columns, and anode is then set such that the wells remain filled but pigment spaced between the rear cover and the columns are swept unto the mesh (30) and anode (26). The viewing side 21 is the color of the pigment in the wells.

By selectively applying voltages to the rows and columns, the pigment in individual wells 24 (at the intersection of the rows and columns selected) is forced out of the wells exposing the dye solution and making that intersection (pixel) dark. The removal of the pigment from the wells is not instantaneous but requires a period of time which depends upon the dimension of the cell or display, the fluid components, and the various applied voltages. The use of the mesh electrode 30 operates to more rapidly propel the pigment particles due to the increased field provided by the additional mesh electrode and hence affords a more rapid removal of particles from the wells. This is also due to the mesh like construction as the apertures in the mesh electrode enhance the field strength.

Referring to Fig. 2, there is shown a planar plan view of an enlarged representation of an electrophoretic display cell or panel according to Fig. 1.

As seen in Fig. 2, each well 24 is accommodated between an intersection of a column 23 which is insulatively separated from a row layer of ITO 25. The well 24 forms a pixel area which is indicative of an X Y intersection on the ITO display.

The pigment particles of course travel between the cathode and anode. As shown in Fig. 2, the anode may be the mesh-like structure 30 or may constitute a separate mesh structure fabricated directly on the layer of glass as above described or a stainless steel mesh 30 may be interposed between the anode and a cathode grid structure as indicated. As seen in Fig. 2, the mesh contains a plurality of apertures which are for example circular holes. It is immediately understood that the mesh may contain any shaped apertures, such as rectangular, square, triangular and so on. Essentially the apertures are extremely small. The mesh is a hardened stainless steel mesh available from many sources. Each aperture is between .0254 mm to .076 mm (10 to 30 mils) in diameter with the space between apertures being of the same magnitude, namely .0254 mm to .076 mm (10 to 30 mils). Preferably the apertures are approximately .038 mm (15 mils) in diameter with the space between the apertures about .038 mm to .051 mm (15 to 20 mils). Hence, as one can ascertain, due to the extremely large number of apertures and due to the spacing between apertures, the hardened stainless steel sheet appears as a total mesh-like structure which is integrally formed and highly conductive. Hence the same can act as an anode electrode or as an intermediate electrode to aid and assist in controlling the pigment particles.

As one can ascertain again from Fig. 1, due to the extremely transparent nature of the mesh-like structure, one can therefore direct light from a source 40 directly through the mesh when an additional ITO coated anode as 26 is not being employed. The above-noted mesh structure creates an electrophoretic display having superior operating characteristics over those provided in the prior art.

Claims

1. An electrophoretic display (10) of the type having an X-Y matrix of intersecting cathode (25) and grid (23) lines and an anode electrode (26) separated from said matrix, with an electrophoretic dispersion located between said anode electrode and said matrix, characterised by:

   said anode electrode being a mesh like structure (30) having a plurality of closely spaced apertures located in the surface thereof and adapted to receive an operating potential to cause pigment particles to migrate to said mesh (30) during display

operation.

2. The apparatus according to claim 1, wherein said anode electrode is a conductive mesh like structure deposited upon a glass layer and separated therefrom by an insulator mesh layer (41).

3. The apparatus according to claim 2, wherein said mesh like structure is a planar sheet of stainless steel having a plurality of closely spaced apertures on the surface thereof.

4. The apparatus according to claim 1, further including a second anode electrode insulated from said mesh like structure and said second anode electrode (26) being a thin layer of a conductive material deposited on a layer of glass (27).

5. The apparatus according to claim 4, wherein said thin layer of conductive material is ITO.

6. The apparatus according to claim 3, wherein said apertures as distributed over the entire surface of said sheet are between .0254 mm - .076 mm (10-30 mils) in diameter and separated one from the other by between .0254 mm - .076 mm (10-30 mils).

7. The apparatus according to claim 6, wherein said apertures are circular in shape.

Patentansprüche

1. Elektrophoretische Anzeige (10) des Typs mit einer X-Y-Matrix sich schneidender Katoden- und Gitterleitungen (25 bzw. 23) und einer von der Matrix getrennten Anodenelektrode (26), wobei zwischen der Anodenelektrode und der Matrix eine elektrophoretische Dispersion liegt, dadurch gekennzeichnet,
daß die Anodenelektrode eine netzartige Struktur (30) mit mehreren dicht beabstandeten Öffnungen ist, die in der Oberfläche liegen und zur Aufnahme eines Betriebspotentials geeignet sind, um zu bewirken, daß Pigmentteilchen während des Anzeigebetriebs zu dem Netz (30) wandern.

2. Vorrichtung nach Anspruch 1, bei welcher die Anodenelektrode eine leitfähige netzartige Struktur ist, die auf eine Glasschicht aufgebracht und davon durch eine Isolatornetzschicht (41) getrennt ist.

3. Vorrichtung nach Anspruch 2, bei welcher die netzartige Struktur eine flächige Schicht aus rostfreiem Stahl mit mehreren dicht beabstandeten Öffnungen in der Oberfläche ist.

4. Vorrichtung nach Anspruch 1, die ferner eine zweite Anodenelektrode umfaßt, die gegen die netzartige Struktur isoliert ist, und wobei die zweite Anodenelektrode (26) eine dünne Schicht aus einem leitfähigen Material ist, das auf eine Glasschicht (27) aufgebracht ist.

5. Vorrichtung nach Anspruch 4, bei welcher die dünne Schicht aus leitfähigem Material aus ITO besteht.

6. Vorrichtung nach Anspruch 3, bei welcher die über die gesamte Fläche der Lage verteilten Öffnungen einen Durchmesser zwischen 0,0254 mm und 0,076 mm (10 bis 30 mil) besitzen und um zwischen 0,0254 mm und 0,076 mm (10 - 30 mil) voneinander getrennt sind.

7. Vorrichtung nach Anspruch 6, bei welcher die Öffnungen kreisförmig sind.

Revendications

1. Afficheur électrophorétique (10) du type ayant une matrice X-Y de lignes de cathode (25) et de grille (23) se coupant et une électrode d'anode (26) distincte de ladite matrice, une dispersion électrophorétique étant située entre ladite électrode d'anode et ladite matrice, caractérisé en ce que :
ladite électrode d'anode a une structure en forme de treillis (30) ayant une pluralité d'ouvertures étroitement espacées situées dans la surface de cette dernière et est conçue pour recevoir un potentiel de fonctionnement pour provoquer la migration de particules de pigment vers ledit treillis (30) pendant l'opération d'affichage.

2. Appareil selon la revendication 1, dans lequel ladite électrode d'anode est une structure, en forme de treillis conducteur, déposée sur une couche de verre et séparée de cette dernière par une couche isolante (41) en treillis.

3. Appareil selon la revendication 2, dans lequel ladite structure en forme de treillis est une feuille plane d'acier inoxydable ayant une pluralité d'ouvertures étroitement espacées dans la surface de cette dernière.

4. Appareil selon la revendication 1, comprenant, de plus, une seconde électrode d'anode isolée de ladite structure en forme de treillis, et ladite seconde électrode d'anode (26) étant une fine couche de matière conductrice déposée sur une couche de verre (27).

5. Appareil selon la revendication 4, dans lequel ladite couche fine de matière conductrice est de l'ITO

(oxyde d'étain dopé à l'indium).

6. Appareil selon la revendication 3, dans lequel lesdites ouvertures, telles que réparties sur la totalité de la surface de ladite feuille, ont un diamètre compris entre 0,0254 mm et 0,076 mm (10 à 30 millièmes de pouce) et sont séparées les unes des autres d'une distance comprise entre 0,0254 mm et 0,076 mm (10 à 30 millièmes de pouce).

7. Appareil selon la revendication 6, dans lequel lesdites ouvertures ont une forme circulaire.

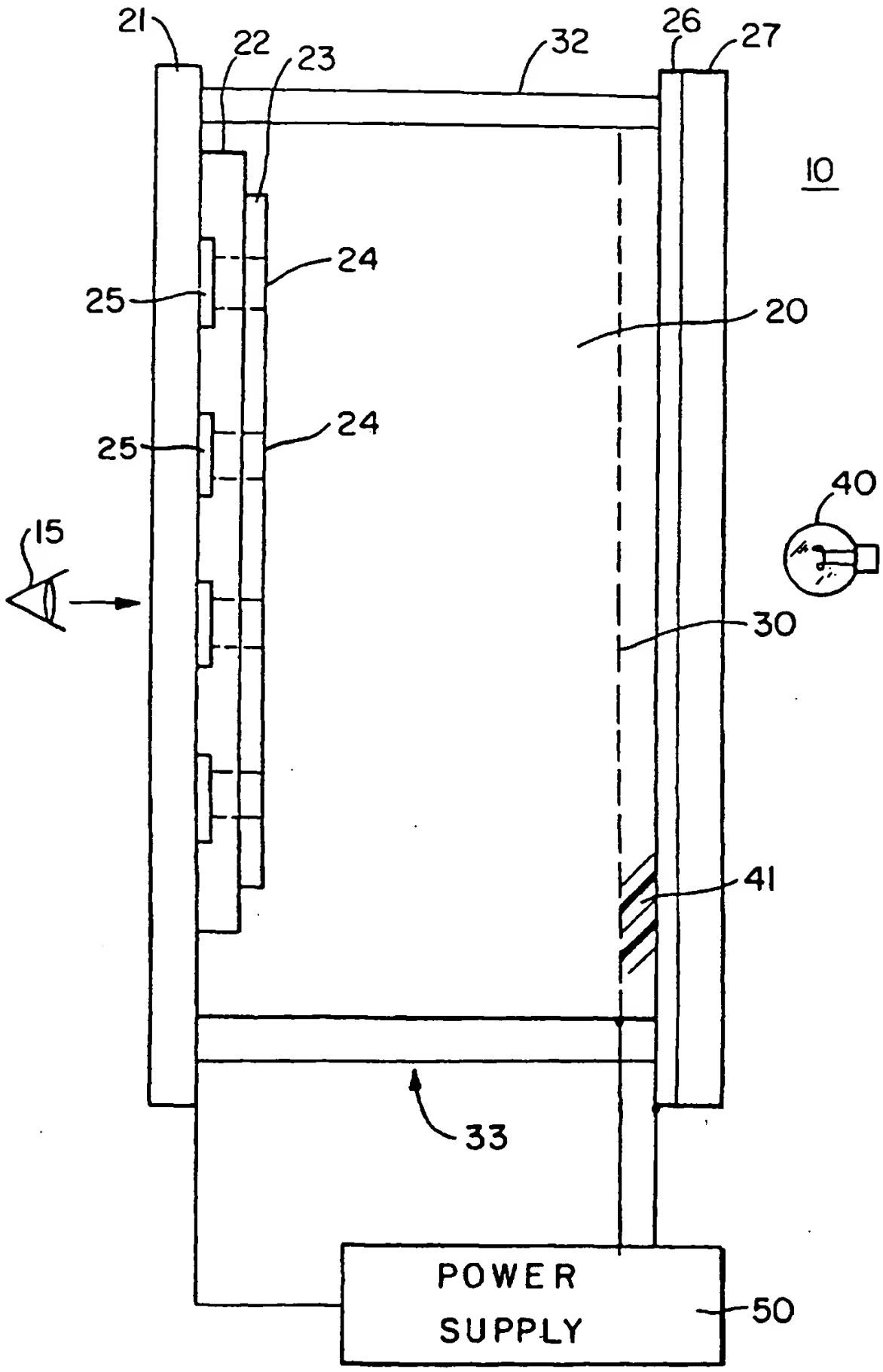

FIG. 1

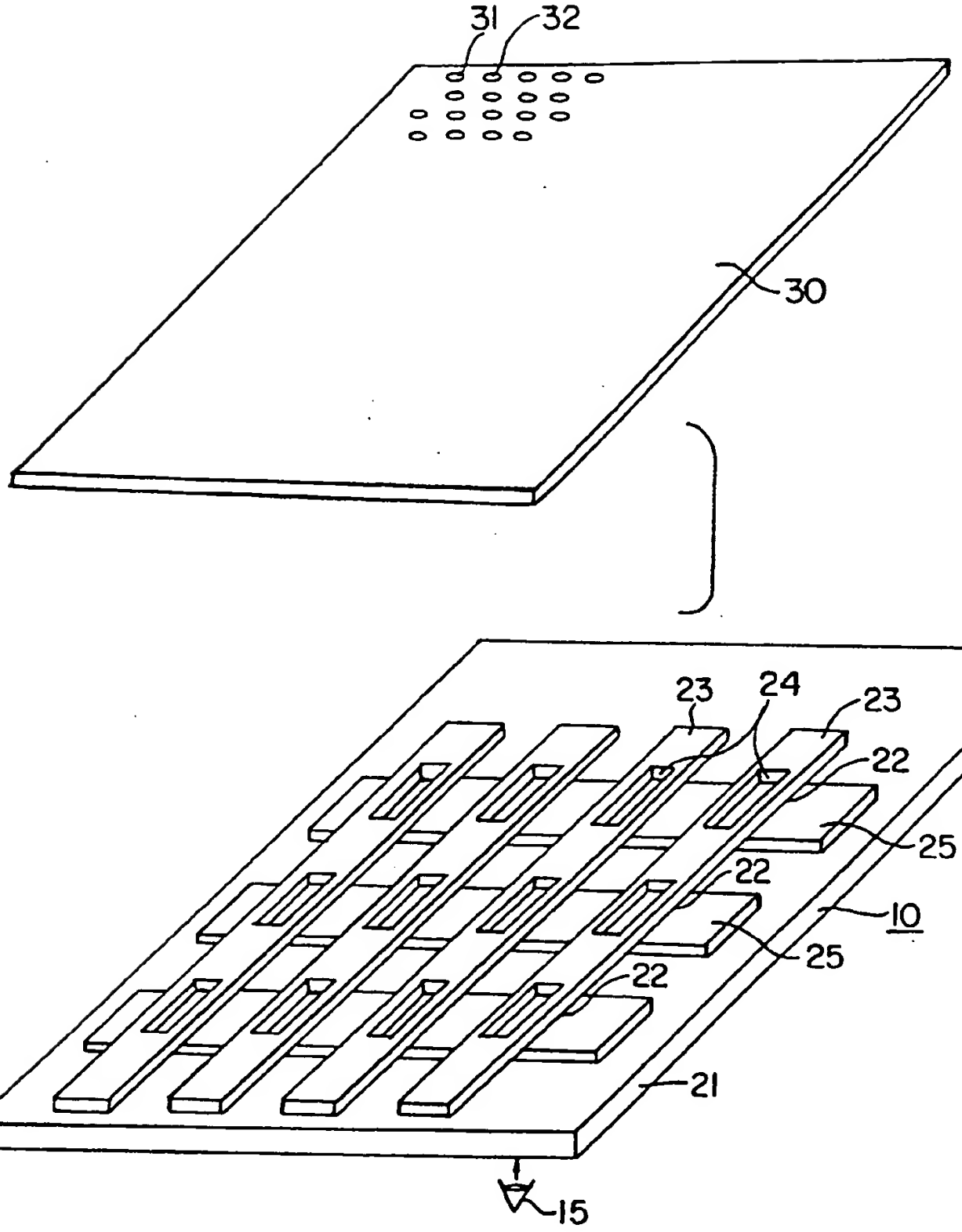

FIG. 2

B15

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Office européen des brevets

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(86) International application number:
PCT/US92/01569

(87) International publication number:
WO 92/15982 (17.09.1992 Gazette 1992/24)

(54) ELECTROPHORETIC DISPLAY PANEL WITH PLURAL ELECTRICALLY INDEPENDENT ANODE ELEMENTS

ELEKTROPHORETISCHE ANZEIGEVORRICHTUNG MIT MEHREREN ELEKTRISCH UNABHAENGIGEN ANODEELEMENTEN

PANNEAU D'AFFICHAGE ELECTROPHORETIQUE POURVU D'UN ENSEMBLE D'ELEMENTS D'ANODE ELECTRIQUEMENT INDEPENDANTS

(84) Designated Contracting States:
BE DE FR GB NL

(30) Priority: **11.03.1991 US 667630**

(43) Date of publication of application:
29.12.1993 Bulletin 1993/52

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- **PATENT ABSTRACTS OF JAPAN vol. 14, no. 337 (P-1079) (4280) 20 July 1990 & JP-A-02 114 239 (KINSEKI) 26 April 1990**

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EP 0 575 475 B1

Description

The present invention relates to electrophoretic display panel apparatus and methods for fabricating same, and more particularly, to a triode-type electrophoretic display panel having an improved anodegrid configuration permitting more efficient electrical connection to display driver circuitry.

A variety of electrophoretic display panels are known. Of most direct pertinence to the present invention are those shown and described in U.S. Patent No. 4,655,897 entitled "Electrophoretic Display Panels and Associated Methods", U.S. Patent No. 4,742,345 entitled "Electrophoretic Display Panel Apparatus and Methods Therefor", and U.S. Patent No. 4,772,820 entitled "Monolithic Flat Panel Display Apparatus". Each of the foregoing U.S. Patents is in the name of Frank J. DiSanto and Denis A. Krusos, the inventors herein, and each is assigned to the assignee herein, Copytele, Inc. The display panels shown in the foregoing patents operate upon the same basic principle, viz., if a suspension of electrically charged pigment particles in a dielectric fluid is subjected to an applied electrostatic field, the pigment particles will migrate through the fluid in response to the electrostatic field. Given a substantially homogeneous suspension of particles having a pigment color different from that of the dielectric fluid, if the applied electrostatic field is localized, it will cause a visually observable localized pigment particle migration. The localized pigment particle migration results either in a localized area of concentration or rarefaction of particles, depending upon the sign and direction of the electrostatic force and the charge on the pigment articles. The electrophoretic display apparatus taught in each of the foregoing U.S. Patents are triode type displays having a plurality of independent, parallel cathode conductor members deposited in the horizontal on one surface of a glass viewing screen. A layer of insulating photoresist material deposited over the cathode members and photoetched down to the cathode members to yield a plurality of insulator strips positioned at right angles to the cathode members, forms the substrate for a plurality of independent, parallel grid conductor members running in the vertical direction. A glass cap member forms a fluid-tight seal with the viewing window along the cap's peripheral edge for containing the fluid suspension and also acts as a substrate for the anode which is a conductor layer deposited on the interior flat surface of the cap. When the cap is in place, the anode surface is in spaced parallel relation to both the cathode members and the grid members. Given a specific particulate suspension, the sign of the electrostatic charge which will attract and repel the pigment particles will be known. The cathode member voltage and the grid member voltage can then be ascertained such that when a particular voltage is applied to the cathode and another voltage is applied to the grid, the area proximate their intersection will assume a net charge sufficient to attract or repel pigment particles in suspension in the dielectric fluid. Since numerous cathode and grid lines are employed, there are numerous discrete intersection points which can be controlled by varying the voltage on the cathode and grid members to cause localized visible regions of pigment concentration and rarefaction. Essentially then, the operating voltages on both cathode and grid must be able to assume at least two states corresponding to a logical one and a logical zero. Logical one for the cathode may either correspond to attraction or repulsion of pigment. Typically, the cathode and grid voltages are selected such that when a given potential difference exists of a given polarity at a given intersection then a sufficient electrostatic field is present at the intersection to cause the writing of a visual bit of information on the display. In this manner, digitized data can be displayed on the electrophoretic display.

The electrophoretic displays described above utilize numerous electrically and physically independent cathode and grid members. For example, an 8-1/2" x 11" display screen with a resolution of 200 lines per inch has 2,200 horizontal cathode row members and 1,700 vertical column grid members. In general, it is desirable to have the greatest number of horizontal and vertical members with the smallest possible width. This results in increased resolution and screen brightness, i.e., the more coordinates, the greater the resolution, the smaller the width of each element, the less the electrophoretic effect is obscured. Thus, the electrophoretic display raises a technical challenge that is common in the field of densely-packed miniaturized electrical devices, viz., while it is possible, using photoetching techniques and the like, to create extremely small circuit components, it is sometimes difficult to make the numerous electrical connections necessary to integrate the miniature components, in this case, the cathode and grid members and the display drivers, into a circuit. A variety of techniques to facilitate connection of miniature components have been developed. For example, U.S. Patent No. 4,772,820 teaches an improved means for connecting numerous miniature cathode and grid members to display drivers. In accordance with that patent, the ends of the cathode and grid members resident upon the surface of the glass viewing screen of the display are metallized and grouped into a pattern which is adapted to electrically connect to mating output contacts of a driver circuit that is bonded to the screen at a predetermined aligned location. The bonding of the respective mating contacts is performed using wire bonding techniques which can be automated to yield quick and efficient connections. In yet a further aspect of the '820 patent the inputs to the driver circuit are also wire bonded to patterned input conductors provided on the surface of the screen thus yielding a substantially monolithic display screen having integral associated driver circuits.

Both U.S. Patent No. 4,742,345 and 4,772,820 utilize a grid comprised of numerous electrically and physically independent vertically-oriented elements which

supply the horizontal coordinate (abscissa) for each displayable location. The grid elements in the foregoing patents are spaced away from the cathode elements by an insulation layer. The connector ends and/or the electrical connections made to screen mounted driver circuits are, however, in the same plane as the cathode elements, i.e., deposited upon the surface of the viewing screen. Each grid element, therefore, must have a conductive path from the plane of the grid to the plane of the screen surface which is spaced therefrom by the insulation layer. Further, since both the grid connector/connections and the cathode connectors/connections are disposed on one surface, i.e., around the periphery of the viewing area, this border area is congested.

It is therefore an object of the present invention to provide an electrophoretic display which eliminates a conductor pathway from the plane of the grid to that of the viewing screen, or, in other words, to provide vertical display conductors which may reside in the same plane as their connector ends/connections.

It is a further object to relieve the congestion of circuit components and conductor pathways around the periphery of the display area of an electrophoretic display screen.

It is yet another object to provide an electrophoretic display which is easier and more economical to produce by simplifying the connection of the numerous vertical display elements to their respective driver circuits.

The problems and disadvantages associated with conventional electrophoretic displays are overcome by the present invention as defined in claim 1 which includes a fluid-tight envelope having a portion thereof which is at least partially transparent for containing an electrophoretic fluid. The fluid has pigmented particles suspended therein. The envelope further contains a plurality of elongated substantially parallel horizontal conductor members disposed within a first plane, as well as a plurality of elongated substantially parallel vertical conductor members electrically insulated from the horizontal members and disposed within a second plane. The first and second planes are substantially parallel and the horizontal members and vertical members form a matrix with a plurality of intersections when viewed along a line perpendicular to the first and second planes. A grid which is substantially electrically equipotential at all points thereof is interposed between and electrically insulated from the horizontal and vertical members. The grid has a plurality of pores therein capable of admitting the fluid. The horizontal and vertical members each are selectively electrically chargeable to induce movement of the particles within the fluid, the particles being at least partially visible through the transparent portion of the envelope.

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic plan view of the interior surface of a triode-type electrophoretic display panel faceplate, which, when assembled to constitute a fluid containing envelope, would be interior to the envelope, and which is in accordance with an exemplary embodiment of the present invention.

FIG. 2 is a diagrammatic plan view of the interior surface of a triode-type electrophoretic display panel backplate, which, when assembled to constitute a fluid containing envelope, would be interior to the envelope, and which is in accordance with an exemplary embodiment of the present invention.

FIG. 3 is a cross-sectional view of an electrophoretic display panel assembled into a fluid containing envelope using the faceplate of FIG. 1 and the backplate of FIG. 2 assembled to an interposed sealing wall.

FIG. 4 is an exemplary line-by-line sequence of voltage state sets for a hypothetical 3 cathode element X 3 anode element electrophoretic display constructed in accordance with the present invention as shown in FIGS. 1, 2 and 3, each line listing in the first column the observable effect on the display resulting from the set of voltage states listed in the subsequent columns of that line.

FIG. 5 is a diagrammatic depiction of a screen output image resulting from the sequential assumption of the voltage state sets of FIG. 4, assuming the same hypothetical 3 X 3 display as was assumed with respect to FIG. 4.

FIG. 1 shows the rear or interior side of a faceplate 10 of an electrophoretic display panel 12 (see FIG. 3) in accordance with the present invention. The anode conductors which are shown in FIG. 2 on the backplate are shown dashed in FIG. 1. The faceplate 10 is typically formed from glass and serves as a substrate upon which is deposited a plurality of independent, electrically conductive cathode members 14 (horizontal rows) using conventional deposition and etching techniques. It is preferred that the cathode members 14 be composed of Indium-Tin-Oxide (ITO) as set forth in U.S. Patent No. 4,742,345, which is incorporated herein by reference, and which teaches an exemplary method for forming the cathode members 14. A grid 16 is superposed over the cathode members 14 and is insulated therefrom by an interstitial photoresist layer 18 (see FIG. 3). The grid 16 is an electrically equipotential element, i.e., the entire grid is in electrical continuity. The grid 16 may be formed by coating the photoresist layer 18 with a metal, such as nickel, using sputtering techniques, or the like, and then selectively masking and etching a plurality of pores 20 through the metal layer, or by depositing a plurality of grid lines in one direction then overlaying in electrically conductive association therewith another set of grid lines perpendicular thereto. Whichever method is employed, the resultant grid 16 preferably has a pore size of approximately 10 μm, a pore center-to-center spacing of about 20 μm and a grid thickness of approximately 3000Å. The grid 16 is provided with a single con-

ductor pathway 22 leading therefrom to a terminal 24 for receiving a voltage source. Consequently. the entire grid 16 is maintained at a single electrical potential across its entire area during operation of the display. This is in contrast to the previous grid structures which were comprised of discrete elements that could assume a variety of voltages during operation corresponding to the display operations of erase, hold and write. The present invention utilizes electrically and physically discrete anode elements 26 (see FIG. 2) to supply the horizontal coordinate (abscissa) specifying where display operations occur in place of the discrete grid elements previously used. The assembled position of the anode elements 26a with respect to the grid 16 and the cathode elements 14 is depicted in FIG. 1 in dashed lines. As in previous displays, e.g., see U.S. Patent No. 4,742,345, each cathode member 14 terminates at one end in a contact pad 28 which is merely an enlargement of the element facilitating connection to display driver circuitry 30. Of course, if the connections 32 are, e.g., printed in the same operation as the cathode elements 14. contact pads 28 would not be necessary. The same comments apply to the anode elements 26, discussed further below. In the embodiment shown, a representative row driver circuit 30 is bonded to the faceplate 10 in accordance with the teachings of U.S. Patent No. 4,772,820, which is incorporated herein by reference. An actual display would utilize numerous such circuits as described in U.S. Patent No. 4,772,820. the number of cathode members 14 shown, i.e., three, is also, of course, greatly reduced for ease of illustration, as actual displays would have in the order of 2,200 such cathode members 14. An input terminal 34 is shown connected to each driver circuit 30 for purposes of illustration. More verisimilar illustrations depicting the number and arrangement of such input terminals 34 can be seen in U.S. Patent No. 4,772,820.

FIG. 2 shows the front or interior side of a backplate 36 of an electrophoretic display panel 12 (see FIG. 3) in accordance with the present invention. The back plate 36 is preferably formed from glass and serves as a substrate upon which is deposited a plurality of independent electrically conductive anode members 26 (vertical columns). It is preferred that the anode members 26 be formed from a metal such as chrome. Besides the fact that they drive the anode members 26, rather than the cathode members 14, the anode display driver circuits 38, connections 40 from the anode element contact pads 42 to the circuits 38, and anode input terminals 44 have the same form and function as the corresponding elements connected to the cathode members 14 and described in reference to FIG. 1. It should be noted that the anode members 26, their contact pads 42, and any connections to anode driver circuits 40, as well as the anode driver circuits 38 and anode input terminals 44, all reside on the surface of the backplate 36. This configuration does not require multiple electrical connections to be formed between elements residing in different planes. Thus, by utilizing the anode members 26 in place of discrete grid members to establish the abscissa of a display coordinate pair, the undesirable connections between two planes are eliminated. Further, since the vertical anode members 26 and their connections and driver circuitry are located on the backplate 36 instead of the faceplate 10, congestion around the periphery of the faceplate is reduced by approximately one half.

FIG. 3 shows the faceplate 10 and backplate 36 of FIGS. 1 and 2 sealably assembled to a peripheral sealing wall 46 to form an envelope for containing a dielectric fluid/pigment particle suspension (not shown). The faceplate 10, backplate 36 and wall 46 are sealably joined by gluing, heat sealing or any other conventional method for forming sealed glass envelopes. It should be observed that the pores 20 of the grid 16 extend through the grid 16 and also through the insulating photoresist layer 18, so that the electrophoretic fluid is in contact with the cathode members 14 via the pores 20. The extension of the pores 20 through the photoresist layer 18 can be formed through the conventional processes and techniques described in U.S. Patent Nos. 4,742,345. The dimensions of the cathode members 14, insulating layer 18, grid 16, and anode members 26 are all greatly exaggerated to facilitate illustration. In actuality the cathode members preferably are approximately 1200Å thick, the grid 16, approximately 500Å thick and the anode members 26, approximately 3000Å thick. Thus, by applying voltages to the cathode members 14, grid 16 and anode members 26, suspended pigment particles in the dielectric fluid can be made to accumulate near, or disperse from, the intersections of selected cathode and anode members to translate these voltages into a visible display. These features with the exception of the respective function of the grid 16 and the anode elements 26, are in accordance with U.S. Patent No. 4,742,345 which patent may be relied upon to supply further details of assembly and function of the display 12.

Referring now to FIG. 4, a table of voltages to be applied to a hypothetical 3X3 display is shown. Each line shows the effect upon the display of a certain combination of voltages applied the 3 cathode members (R1, R2, R3) and the 3 anode members (C1, C2, C3). It should be noted that the grid voltage is held constant in all voltage sets. The voltages, V1, V2, and V3 are a function of the amount of spacing from the anode elements 26 to the grid 16 and cathode elements 14. This spacing is chosen to minimize speading of the electrostatic field between such elements at display points, such speading resulting in a reduced resolution. Assuming a 3 mm spacing between frontplate 10 and backplate 36, appropriate voltage levels would be approximately as follows: V1 = 50 V, V2 = 18 V, and V3 = 10 V. The grid 16 would be maintained at approximately -4 V.

FIG. 5 illustrates the visual effect on a hypothetical 3X3 display achieved by applying the sequence of voltage sets shown in the table of FIG. 4 to a hypothetical

3X3 display constructed in accordance with the present invention, the darkened blocks representing a display bit in the written or "ON" state.

It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the scope of the invention as defined in the appended claims.

Claims

1. An electrophoretic display apparatus (12) comprising:

   (a) a fluid tight envelope having a portion (10) thereof which is at least partially transparent;
   (h) an electrophoretic fluid contained within said envelope, said electrophoretic fluid having pigmented particles suspended therein;
   (c) said envelope further containing therein a plurality of elongated substantially parallel horizontal conductor members (14) disposed within a first plane;
   (d) a plurality of elongated substantially parallel vertical conductor members (26) electrically insulated from said horizontal conductor members (14) and disposed within a second plane, said first and second planes being substantially parallel, said horizontal and vertical conductor members (14,26) forming a matrix with a plurality of intersections when viewed along a line perpendicular to said first and second planes; and
   (e) a continuous electrically conductive grid (16) such that all points thereof have equipotential, the grid (16) being fixedly interposed between and electrically insulated from said horizontal and said vertical conductor members (14,26), said grid (16) having a plurality of pores (20) capable of admitting said electrophoretic fluid therein, said grid (16), said horizontal conductor members (14) and said vertical conductor members (26) being selectively electrically chargeable to induce movement of said particles within said electrophoretic fluid, said particles being at least partially visible through said at least partially transparent portion (10) of said envelope.

2. The device of Claim 1, wherein said envelope includes a substantially flat faceplate (10), a central portion of which is said at least partially transparent portion of said envelope, said faceplate (10) forming a substrate supporting said horizontal conductor members (14) within said first plane.

3. The device of Claim 2, wherein said envelope includes a backplate (36), said backplate (36) forming a substrate supporting said vertical conductor members (26) within said second plane.

4. The device of Claim 3 further including a layer of insulator material (18) overlying said horizontal conductor members (14), said grid (16) being deposited upon said layer of insulator material (18) distal to said horizontal conductor members (14).

5. The device of Claim 4, wherein said layer of insulator material (18) is penetrated by a plurality of bores which permit said electrophoretic fluid to contact said horizontal conductor members (14).

6. The device of Claim 5, wherein said bores at least partially communicate with said pores (20) of said grid such that said fluid can flow through said pores (20) and into said bores.

7. The device of Claim 6, wherein said electrophoretic display is a triode-type device, said horizontal conductor members (14) constituting a cathode, said grid (16) being a grid of said triode and said vertical conductor members (26) constituting an anode of said triode.

8. The device of Claim 7, further including a side wall (46) interposed between and sealably affixed to said faceplate (10) and said backplate (36) to form said fluid tight envelope.

9. The device of Claim 8, wherein said faceplate (10) is glass, and said horizontal conductor members (14) are composed of Indium-Tin-Oxide.

10. The device of Claim 9, wherein said backplate (36) is glass and said vertical conductor members (26) are at least partially composed of chrome.

11. The device of Claim 6, wherein each of said plurality of elongated substantially parallel horizontal members (14) and each of said plurality of elongated substantially parallel vertical conductor members (26) have an end for electrically connecting to an associated voltage source and a free end.

12. The device of Claim 11, wherein said ends for electrically connecting and said free ends of succeeding said horizontal conductor members (14) are positioned in proximity to one another on said faceplate (10) surface.

13. The device of Claim 12, wherein said ends for electrically connecting and said free ends of succeeding said vertical conductor members (26) are positioned in proximity to one another on said backplate (36) surface.

14. The device of Claim 11, further including at least one row display driver circuit (30) affixed to said faceplate (10) and electrically connected by electrical connections (32) to said horizontal conductor members (14).

15. The device of Claim 14, further including at least one column display driver circuit (38) affixed to said backplate (36) and electrically connected by electrical connections (40) to said vertical conductor members (26).

16. The device of Claim 15, wherein said horizontal conductor members (14), said at least one row display driver circuit (30) and said electrical connections (32) therebetween all reside substantially in said first plane.

17. The device of Claim 16, wherein said vertical conductor members (26), said at least one column display driver circuit (38), and said electrical connections (40) therebetween all reside substantially in said second plane.

18. The device of Claim 17, further including input terminals (34) disposed on said faceplate (10) in said first plane for said at least one row display driver circuit (30).

19. The device of Claim 18, further including input terminals (44) disposed on said backplate (36) in said second plane for said at least one column display driver circuit (38).

Patentansprüche

1. Eine elektrophoretische Anzeigevorrichtung (12) mit:

(a) einer fluiddichten Umhüllung, deren einer Abschnitt (10) wenigstens teilweise transparent ist;

(b) einem elektrophoretischen Fluid, das von der Umhüllung aufgenommen wird, wobei das elektrophoretische Fluid pigmentierte Partikel hat, die in diesem verteilt sind;

(c) wobei die Umhüllung weiter eine Vielzahl von länglichen, im wesentlichen parallelen horizontalen Leiterelementen (14) aufweist, die in einer ersten Ebene angeordnet sind (14);

(d) einer Mehrzahl von länglichen, im wesentlichen parallelen, vertikal verlaufenden Leiterelementen (26), die elektrisch von dem horizontalen Leiterelementen (14) isoliert und in einer zweiten Ebene verteilt sind, wobei die erste und die zweite Ebene im wesentlichen parallel zueinander liegen, die horizontalen und vertikalen Leiterelemente (14, 26) eine Matrix mit einer Mehrzahl von Zwischenabschnitten bilden, gesehen entlang einer Linie senkrecht zu der ersten und zu der zweiten Ebene; und

(e) einem kontinuierlichen, elektrisch leitfähigen Gitter (16) derart, daß alle deren Punkte das gleiche Potential haben, wobei das Gitter (16) fest zwischen den horizontalen und den vertikalen Leiterelementen (14, 16) angeordnet und von diesen elektrisch isoliert ist, das Gitter (16) eine Vielzahl von Poren (20) hat, die dazu in der Lage sind, das elektrophoretische Fluid in sich aufzunehmen, das Gitter (16), die horizontalen Leiterelemente (14) und die vertikalen Leiterelemente (16) wahlweise elektrisch geladen werden können, um eine Bewegung in den Partikeln innerhalb des elektrophoretischen Fluids zu bewirken, wobei die Partikel wenigstens teilweise durch den wenigstens teilweise transparenten Abschnitt (10) der Umhüllung sichtbar sind.

2. Die Vorrichtung nach Anspruch 1, wobei die Umhüllung eine im wesentlichen flache Sichtplatte (10) hat, deren Zentralabschnitt der wenigstens teilweise transparente Abschnitt der Umhüllung ist, wobei die Sichtplatte (10) ein Substrat bildet, das die horizontalen Leiterelemente (14) in der ersten Ebene trägt.

3. Die Vorrichtung von Anspruch 2, wobei die Umhüllung eine Rückplatte (36) aufweist, die einen Träger bildet, der die vertikalen Leiterelemente (26) in der zweiten Ebene trägt.

4. Die Vorrichtung von Anspruch 3, weiter mit einer Schicht aus einem Isolationsmaterial (18), das die horizontalen Leiterelemente (14) überlappt, wobei das Gitter (16) auf der Schicht aus dem Isolationsmaterial (18) entfernt von den horizontalen Leiterelementen (14) aufgebracht ist.

5. Die Vorrichtung von Anspruch 4, wobei die Schicht aus dem Isolationsmaterial (18) von einer Mehrzahl von Bohrungen durchdrungen ist, die es dem elektrophoretischen Fluid erlauben, die horizontalen Leiterelemente (14) zu kontaktieren.

6. Die Vorrichtung von Anspruch 5, wobei die Bohrungen wenigstens teilweise mit den Poren (22) derart kommunizieren, daß das Fluid durch die Poren (20) und in den Bohrungen strömen kann.

7. Die Vorrichtung von Anspruch 6, wobei die elektro-

phoretische Anzeige vom Triode-Typ ist, bei der die horizontalen Leiterelemente (14) eine Kathode bilden, das Gitter (16) ein Gatter der Triode ist und die vertikalen Leiterelemente (26) eine Anode der Triode bilden.

8. Die Vorrichtung von Anspruch 7 weiter mit einer Seitenwandung (46), die zwischen der Sichtplatte (10) und der Rückplatte (36) angeordnet und mit diesen abdichtend verbunden ist, um die fluiddichte Umhüllung zu schaffen.

9. Die Vorrichtung von Anspruch 8, wobei die Sichtplatten (10) aus Glas ist und die horizontalen Leiterelemente (14) aus Indium-Tin-Oxide gebildet sind.

10. Die Vorrichtung von Anspruch 9, wobei die Rückplatte (36) Glas ist und die vertikalen Leiterelemente (26) wenigstens teilweise aus Chrom gebildet sind.

11. Die Vorrichtung nach Anspruch 6, wobei jedes aus der Mehrzahl von länglichen, im wesentlichen parallelen horizontalen Elementen (14) und jedes aus der Mehrzahl von länglichen, im wesentlichen parallelen vertikalen Leiterelementen (26) ein Ende für eine elektrische Verbindung mit einer zugehörigen Spannungsquelle und ein freies Ende haben.

12. Die Vorrichtung von Anspruch 11, wobei die zur elektrischen Verbindung dienenden Enden und die freien Enden von aufeinanderfolgenden der horizontalen Leiterelemente (14) in Nähe zueinander auf der Oberfläche der Sichtplatte (10) positioniert sind.

13. Die Vorrichtung von Anspruch 12, wobei die zur elektrischen Verbindung dienenden Enden und die freien Enden benachbarter der vertikalen Leiterelemente (26) in Nähe zueinander auf der Oberfläche der Rückplatte (36) positioniert sind.

14. Die Vorrichtung von Anspruch 11, weiter mit wenigstens einem auf der Sichtplatte (10) befestigen und elektrisch durch elektrische Verbinder (32) mit den horizontalen Leiterelementen (14) verbundenen Reihenanzeigetreiberschaltung (30).

15. Die Vorrichtung nach Anspruch 14, weiter mit wenigstens einer an der Rückplatte (36) befestigten und elektrisch über elektrische Verbinder (40) mit den vertikalen Leiterelementen (26) verbundenen Säulenanzeigetreiberschaltung (38).

16. Die Vorrichtung von Anspruch 15, wobei die horizontalen Leiterelemente (14), die wenigstens eine Reihenanzeigetreiberschaltung (30) und die elektrischen Verbinder (32) dazwischen alle im wesentlichen in der ersten Ebene ruhen.

17. Die Vorrichtung von Anspruch 16, wobei die vertikalen Leiterelemente (26), die wenigstens eine Säulenanzeigetreiberschaltung (38) und die elektrischen Verbinder (40) dazwischen alle im wesentlichen in der zweiten Ebene ruhen.

18. Die Vorrichtung von Anspruch 17, weiter mit Eingangsanschlüssen (34), die auf der Lichtplatte (10) in der ersten Ebene für die wenigstens einen Reihenanzeigetreiberschaltung (30) angeordnet sind.

19. Die Vorrichtung von Anspruch 18, weiter mit Eingangsanschlüssen (44), die auf der Rückplatte (36) in der zweiten Ebene für die wenigstens eine Säulenanzeigetreiberschaltung (38) angeordnet sind.

Revendications

1. Un appareil d'affichage électrophorétique (12) comprenant :

(a) une enveloppe étanche à du fluide ayant une partie (10) qui est au moins partiellement transparente ;
(b) un fluide électrophorétique contenu dans ladite enveloppe, ledit fluide électrophorétique ayant des particules pigmentées suspendues dans celui-ci ;
(c) ladite enveloppe contenant en outre une pluralité d'éléments conducteurs horizontaux sensiblement parallèles allongés (14) disposés dans un premier plan ;
(d) une pluralité d'éléments conducteurs verticaux sensiblement parallèles allongés (26), isolés électriquement desdits éléments conducteurs horizontaux (14) et disposés dans un second plan, lesdits premier et second plans étant sensiblement parallèles, lesdits éléments conducteurs horizontaux et verticaux (14, 26) formant une matrice avec une pluralité d'intersections lorsqu'ils sont vus le long d'une ligne perpendiculaire auxdits premier et second plans ; et
(e) une grille continue électriquement conductrice (16) de sorte que tous les points de celle-ci soient équipotentiels, la grille (16) étant interposée de façon fixe entre lesdits et électriquement isolée desdits éléments conducteurs horizontaux et verticaux (14, 26), ladite grille (16) ayant une pluralité de pores (20) capables de recevoir ledit fluide électrophorétique dans ceux-ci, ladite grille (16), lesdits éléments conducteurs horizontaux (14) et lesdits éléments conducteurs verticaux (26) pouvant être sélec-

tivement chargés électriquement pour induire un mouvement desdites particules dans ledit fluide électrophorétique, lesdites particules étant au moins partiellement visibles à travers ladite partie au moins partiellement transparente (10) de ladite enveloppe.

2. Le dispositif de la Revendication 1, dans lequel ladite enveloppe inclut une plaque avant sensiblement plate (10), dont une partie centrale est ladite partie au moins partiellement transparente de ladite enveloppe, ladite plaque avant (10) formant un substrat supportant lesdits éléments conducteurs horizontaux (14) dans ledit premier plan.

3. Le dispositif de la Revendication 2, dans lequel ladite enveloppe inclut une plaque arrière (36), ladite plaque arrière (36) formant un substrat supportant lesdits éléments conducteurs verticaux (26) dans ledit second plan.

4. Le dispositif de la Revendication 3 incluant en outre une couche de matériau isolant (18) recouvrant lesdits éléments conducteurs horizontaux (14), ladite grille (16) étant déposée sur ladite couche de matériau isolant (18) distale auxdits éléments conducteurs horizontaux (14).

5. Le dispositif de la Revendication 4, dans lequel ladite couche de matériau isolant (18) est pénétrée par une pluralité de trous qui permettent audit fluide électrophorétique d'être en contact avec lesdits éléments conducteurs horizontaux (14).

6. Le dispositif de la Revendication 5, dans lequel lesdits trous communiquent au moins partiellement avec lesdits pores (20) de ladite grille de sorte que ledit fluide puisse couler à travers lesdits pores (20) et dans lesdits trous.

7. Le dispositif de la Revendication 6, dans lequel l'affichage électrophorétique est un dispositif de type triode, lesdits éléments conducteurs horizontaux (14) constituant une cathode, ladite grille (16) étant une grille de ladite triode et lesdits éléments conducteurs verticaux (26) constituant une anode de ladite triode.

8. Le dispositif de la Revendication 7, incluant en outre une paroi latérale (46) interposée et fixée de façon étanche entre ladite plaque avant (10) et ladite plaque arrière (36) pour former ladite enveloppe étanche à du fluide.

9. Le dispositif de la Revendication 8, dans lequel ladite plaque avant (10) est du verre, et lesdits éléments conducteurs horizontaux (14) sont conçus en Oxyde d'Indium-Etain.

10. Le dispositif de la Revendication 9, dans lequel ladite plaque arrière (36) est du verre et lesdits éléments conducteurs verticaux (26) sont au moins partiellement composés de chrome.

11. Le dispositif de la Revendication 6, dans lequel chacun de ladite pluralité d'éléments horizontaux sensiblement parallèles allongés (14) et chacun de ladite pluralité d'éléments conducteurs verticaux sensiblement parallèles allongés (26) ont une extrémité pour se connecter électriquement à une source de tension associée et une extrémité libre.

12. Le dispositif de la Revendication 11, dans lequel lesdites extrémités pour se connecter électriquement et lesdites extrémités libres desdits éléments conducteurs horizontaux (14) successifs sont positionnées à proximité l'une de l'autre sur une surface de ladite plaque avant (10).

13. Le dispositif de la Revendication 12, dans lequel lesdites extrémités pour se connecter électriquement et lesdites extrémités libres desdits éléments conducteurs verticaux (26) successifs sont positionnées à proximité l'une de l'autre sur une surface de ladite plaque arrière (36).

14. Le dispositif de la Revendication 11, incluant en outre un circuit de commande d'affichage d'au moins une rangée (30) fixé à ladite plaque avant (10) et connecté électriquement par des connexions électriques (32) auxdits éléments conducteurs horizontaux (14).

15. Le dispositif de la Revendication 14, incluant en outre un circuit de commande d'affichage d'au moins une colonne (38) fixé à ladite plaque arrière (36) et connecté électriquement par des connexions électriques (40) auxdits éléments conducteurs verticaux (26).

16. Le dispositif de la Revendication 15, dans lequel lesdits éléments conducteurs horizontaux (14), ledit circuit de commande d'affichage d'au moins une rangée (30) et lesdites connexions électriques (32) entre ceux-ci reposent tous sensiblement dans ledit premier plan.

17. Le dispositif de la Revendication 16, dans lequel lesdits éléments conducteurs verticaux (26), ledit circuit de commande d'affichage d'au moins une colonne (38), et lesdites connexions électriques (40) entre ceux-ci reposent tous sensiblement dans ledit second plan.

18. Le dispositif de la Revendication 17, incluant en outre des bornes d'entrée (34) disposées sur ladite plaque avant (10) dans ledit premier plan pour ledit

circuit de commande d'affichage d'au moins une rangée (30).

19. Le dispositif de la Revendication 18, incluant en outre des bornes d'entrée (44) disposées sur ladite plaque arrière (36) dans ledit second plan pour ledit circuit de commande d'affichage d'au moins une colonne (38).

FIG-1

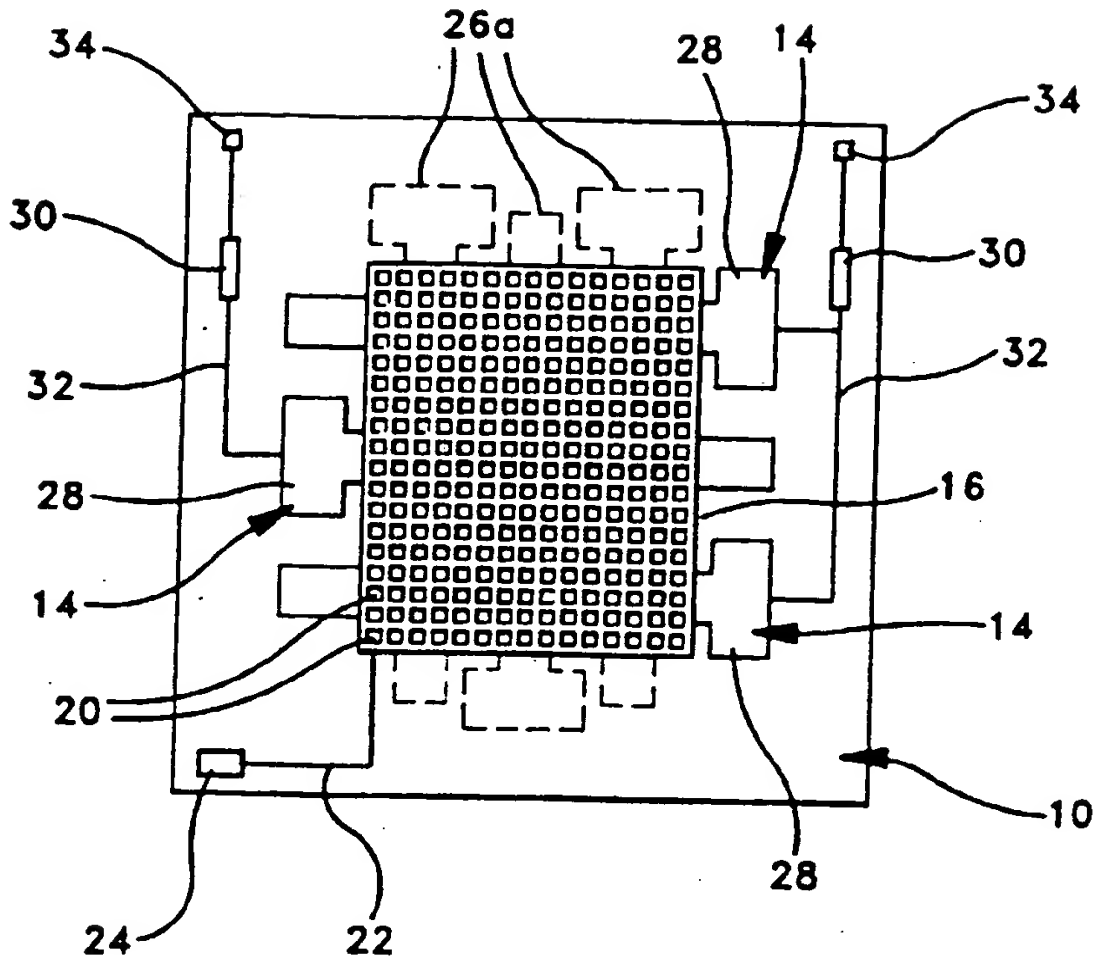
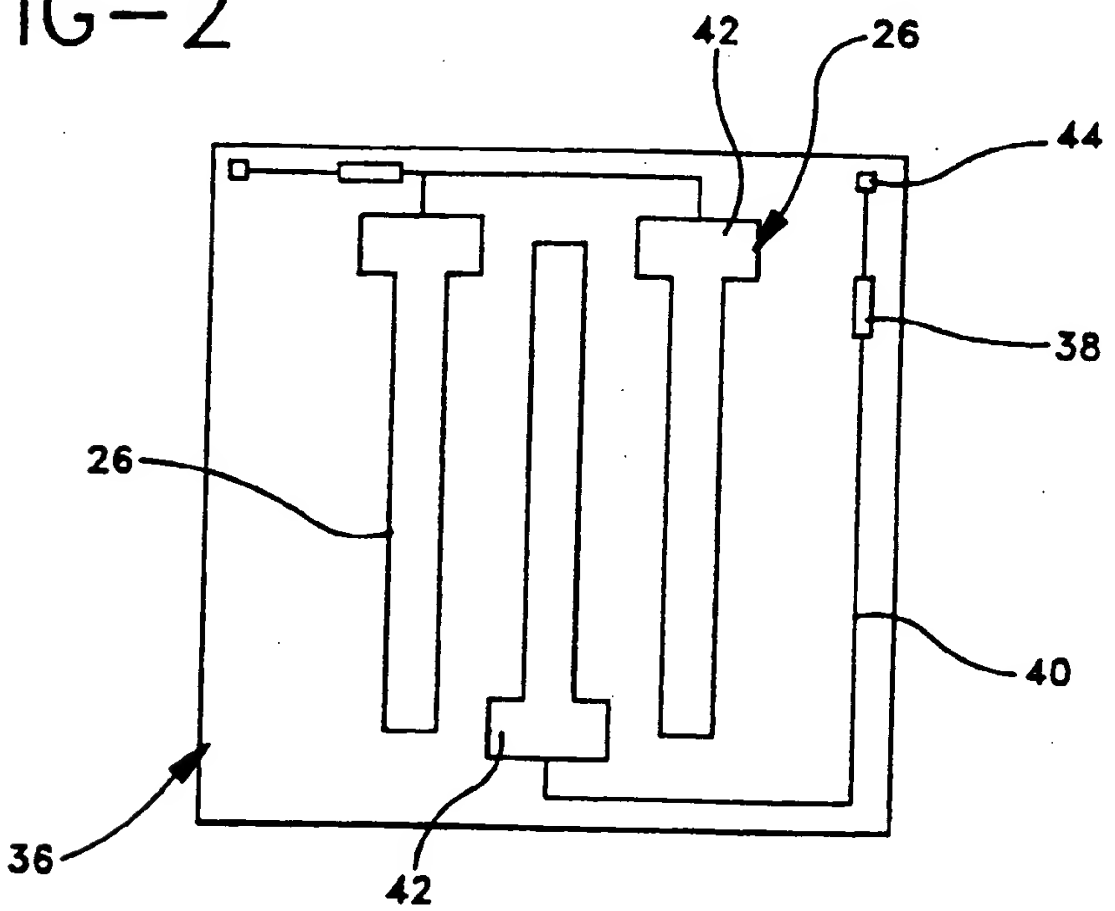
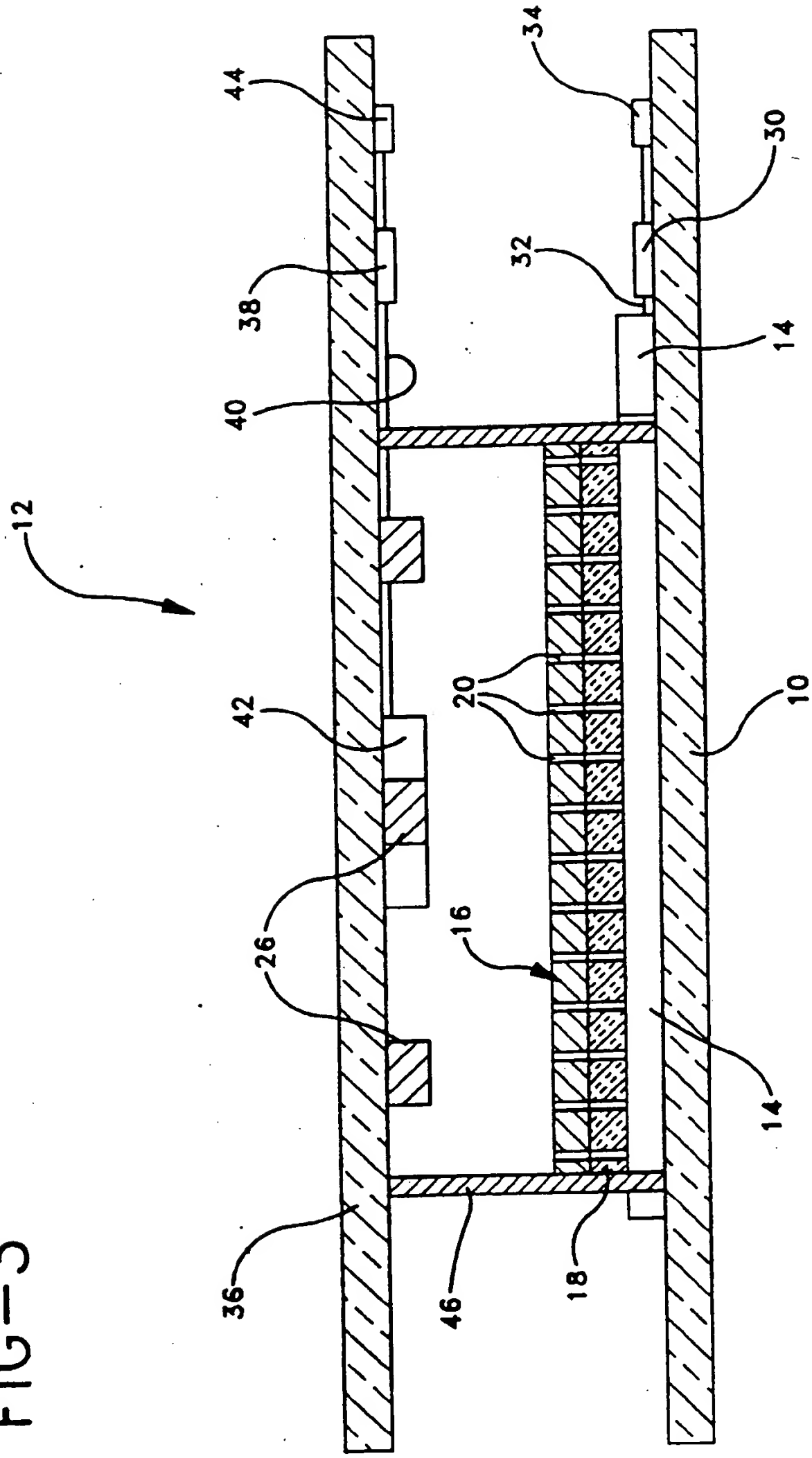

34
26a
28
14
34
30
30
32
32
28
16
14
14
20
10
28
24
22

FIG-2


42
26
44
38
26
40
36
42

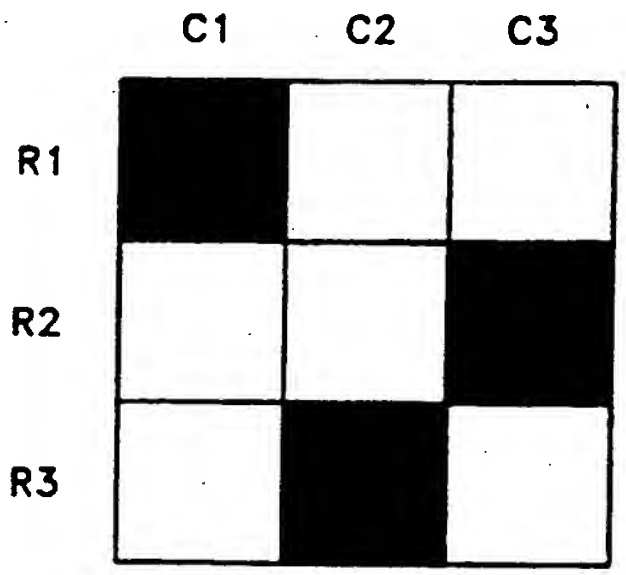


FIG—3

FIG-4

	R1	R2	R3	C1	C2	C3	G
ERASE	0	0	0	$-V_1$	$-V_1$	$-V_1$	$-V$
HOLD	$+V_3$	$+V_3$	$+V_3$	$+V_2$	$+V_2$	$+V_2$	$-V$
WRITE R1-C1	0	$+V_3$	$+V_3$	$+V_1$	$+V_2$	$+V_2$	$-V$
HOLD	$+V_3$	$+V_3$	$+V_3$	$+V_2$	$+V_2$	$+V_2$	$-V$
WRITE R2-C2	$+V_3$	0	$+V_3$	$+V_2$	$+V_2$	$+V_1$	$-V$
HOLD	$+V_3$	$+V_3$	$+V_3$	$+V_2$	$+V_2$	$+V_2$	$-V$
WRITE R3-C3	$+V_3$	$+V_3$	0	$+V_2$	$+V_1$	$+V_2$	$-V$

FIG-5



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(54) ELECTROPHORETIC DISPLAY WITH SINGLE CHARACTER ERASURE

ELEKTROPHONETISCHE ANZEIGEVORRICHTUNG MIT ZEICHENLÖSCHUNG

AFFICHAGE ELECTROPHORETIQUE A EFFACEMENT DE CARACTERES INDIVIDUELS

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Description

The present invention relates to electrophoretic displays, and more particularly to a display capable of selective erasure of displayed data.

Electrophoretic displays are now well known. A variety of display types and features are taught in several patents issued in the names of the inventors herein, Frank J. DiSanto and Denis A. Krusos and assigned to the assignee herein, Copytele, Inc. of Huntington Station New York. For example, U.S. Patent Nos. 4,655,897 and 4,732.830, each entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS describe the basic operation and construction of an electrophoretic display. U.S. Patent No. 4,742,345, entitled ELECTROPHORETIC DISPLAY PANELS AND METHODS THEREFOR, describes a display having improved alignment and contrast. The inventors herein also have several applications relating to electrophoretic displays presently pending in the Patent Office. Three such applications which may have some relevance to the present invention are Application No. 07/375,056 (published as U.S. Patent No. 5,066,946) entitled ELECTROPHORETIC DISPLAY PANEL WITH SELECTIVE LINE ERASURE, Application No. 07/667,630 (published as U.S. Patent No. 5,223,823) entitled ELECTROPHORETIC DISPLAY PANEL WITH PLURAL ELECTRICALLY INDEPENDENT ANODE ELEMENTS and Application No. 07/345,825 (published as a European Patent Application under No. EP 0396247) entitled DUAL ANODE FLAT PANEL ELECTROPHORETIC DISPLAY APPARATUS, each of which shall be described below to point out their potential relevance.

The display panels shown in the above-mentioned patents operate upon the same basic principle, viz., if a suspension of electrically charged pigment particles in a dielectric fluid is subjected to an applied electrostatic field, the pigment particles will migrate through the fluid in response to the electrostatic field. Given a substantially homogeneous suspension of particles having a pigment color different from that of the dielectric fluid, if the applied electrostatic field is localized it will cause a visually observable localized pigment particle migration. The localized pigment particle migration results either in a localized area of concentration or rarefaction of particles depending upon the sign and direction of the electrostatic field and the charge on the pigment particles. The electrophoretic display apparatus taught in the foregoing U.S. Patents are "triode-type" displays having a plurality of independent, parallel, cathode row conductor members deposited in the horizontal on one surface of a glass viewing screen. A layer of insulating photoresist material deposited over the cathode members and photoetched down to the cathode members to yield a plurality of insulator strips positioned at right angles to the cathode members, forms the substrate for a plurality of independent, parallel column grid conductor members running in the vertical direction. A glass cap member forms a fluid-tight seal with the viewing window along the cap's peripheral edge for containing the fluid suspension and also acts as a substrate for an anode plate deposited on the interior flat surface of the cap. When the cap is in place, the anode surface is in spaced parallel relation to both the cathode members and the grid members. Given a specific particulate suspension, the sign of the electrostatic charge which will attract and repel the pigment particles will be known. The cathode member voltage, the anode voltage, and the grid member voltage can then be ascertained such that when a particular voltage is applied to the cathode and another voltage is applied to the grid, the area proximate their intersection will assume a net charge sufficient to attract or repel pigment particles in suspension in the dielectric fluid. Since numerous cathode and grid lines are employed, there are numerous discrete intersection points which can be controlled by varying the voltage on the cathode and grid members to cause localized visible regions of pigment concentration and rarefaction. Essentially then, the operating voltages on both cathode and grid must be able to assume at least two states corresponding to a logical one and a logical zero. Logical one for the cathode may either correspond to attraction or repulsion of pigment. Typically, the cathode and grid voltages are selected such that only when both are a logical one at a particular intersection point, will a sufficient electrostatic field be present at the intersection relative to the anode to cause the writing of a visual bit of information on the display through migration of a pigment particle. The bit may be erased, e.g., upon a reversal of polarity and a logical zero-zero state occurring at the intersection coordinated with an erase voltage gradient between anode and cathode. In this manner, digitized data can be displayed on the electrophoretic display.

To be useful as a display, an electrophoretic display must be able to assume a blank or erased state; must be able to display character data written during a Write operation; and must be able to continually maintain or hold the written characters (and blank characters) in a Hold mode until they are erased or overwritten. These three modes of operation, i.e., Erase, Write and Hold are well documented in existing patents issued to the inventors herein. Certain aspects of these modes of operation are repeated herein, however, for the convenience of the reader. See U.S. Patent 4,947,157 "APPARATUS AND METHODS FOR PULSING THE ELECTRODES OF AN ELECTROPHORETIC DISPLAY FOR ACHIEVING FASTER DISPLAY OPERATION" issued on August 7, 1990 to Frank DiSanto et al. and assigned to Copytele, Inc.

Given a multi-element cathode and multi-element grid structure as described above, a planar anode, electrically negative, light-colored pigment particles, and a dark-colored, electrically-neutral suspension, the anode face can be completely darkened and the cathode face simultaneously completely lightened by applying a suf-

ficiently large negative voltage on the anode. This condition causes the light-colored, negatively charged particles to migrate from the anode to the cathode. On the way to the cathode, the negative particles will pass through the grid which would be maintained at a voltage permitting passage of the particles therethrough, for example, at zero voltage. Once the anode and cathode screens are rendered monochromic by virtue of the accumulation of negatively-charged, light-colored pigment particles on the cathode elements and the absence of pigment particles on the anode, the respective screens may be deemed "erased".

In any event, if reference is made to the above-noted patents, one will see that such cells or electrophoretic displays essentially contain an anode, a cathode and a grid electrode, which grid electrode further controls the transportation of charged particles. In operation, the charged particles are transferred and forced against one electrode, as the anode or cathode under the influence of an applied electric field, so that the viewer may view the color of the pigment which forms a desired display pattern. In this manner the grid electrode is employed to enable control of the migration of such particles. It is also indicated that when the polarity of the field is reversed, the pigment particles are transported and packed on the opposite electrode. This is indicative, for example, of an erasing mode.

The normal voltages on a typical electrophoretic panel enable the following conditions of operation. The panel can be operated in an Erase Mode where the anode electrode is negative with respect to the cathode electrode which is positive. In this mode the grid electrodes are at a low potential which is equivalent for example to a binary O. In a Hold Mode the anode is positive, the cathodes are positive and the grid electrodes are essentially at zero voltage or at binary 0 level. As one can understand, the cathode operates between zero and positive voltages while the grid operates between low ("0") and high voltages ("1").

As indicated above, a low condition will be indicated by a binary 0 and a high condition is indicated by a binary 1. In any event, during a Write Mode the anode is positive, the cathodes that are being written into are at zero potential and the grids, which are the writing grids, are at a positive or high potential as a binary 1. During this mode all non-writing cathodes are positive and non-writing grids are at low potential or more negative than the cathode.

U.S. Patent No. 5,223.823 relates to another structure for an electrophoretic display in which the previously described grid of electrically independently controllable elements is replaced with a monolithic or electrically continuous grid with pores therein. Further, the monolithic anode is replaced with a plurality of discrete, electrically independent elements. In displays constructed in accordance with the teachings of the aforesaid application, pixel writing and erasure is accomplished by impressing a voltage gradient between a selected anode element and a selected intersecting cathode element such that at their point of intersection, the gradient is sufficient to overcome a constant barrier voltage on the monolithic grid element and cause migration of pigment particles past the grid.

European Application, published under No. 0 396 247 relates to an electrophoretic display having a plurality of independent cathode and grid elements. In addition to a monolithic anode plate (remote anode), a plurality of discrete local anode elements are formed atop and in parallel to either the grid or cathode elements with a corresponding plurality of insulator strips positioned therebetween. This structure is achieved, inter alia, by employing different metals for grid and local anode and performing a two-step etching to form these elements. Selective erasure at the pixel level may be performed by establishing a sufficient voltage gradient at an intersection point of a selected cathode and grid member relative to the remote anode and lowering the potential of the local anode element crossing the particular intersection to ground potential thereby permitting particle passage.

U.S. Patent No. 5,066,946 relates to an electrophoretic display of a type having a plurality of independent cathode and grid elements. The anode is however, divided into a plurality of discrete elements. In Patent No. 5,066,946, a selected line, rather than the entire display screen, can be erased during an erase operation. The independent anode elements are separately addressable and therefore the erase voltage can be impressed upon any selected anode element to erase a line of characters from the display screen. In accordance with the foregoing principles, the typical screen has about 25 horizontal lines for character text; the individual anode elements are approximately 25 in number; and there is one anode element aligned with a corresponding horizontal line of text. All the pixels of an entire line may therefore be erased by impressing the erase voltage upon the corresponding anode element. This feature is beneficial in that the entire screen need not be erased and rewritten when sequential screens differ only slightly. If only the display data which has changed is erased and rewritten, screen rewrite time is saved and display energy requirements are reduced.

A further form of electrophoretic device is described in EP 0 186 519. As for the previous prior art example it comprises a plurality of independent cathode and grid elements and an anode divided into a plurality of discrete elements. Information is written onto the display either repeatedly for set periods of time or for a single selected period of time, in order to implement a grey scale of brightness. Alternatively, the information may be written once for a short period of time, which gives only partial brightness, but may be adequate in some circumstances.

Whereas the above-described applications teach multi-element anodes for use with a monolithic grid; dual anodes, one being monolithic and the other discrete el-

ements parallel to the grid elements for erasure of single pixels. and, in one instance, single line erasure of an electrophoretic display by means of a multi-element anode, there is no prior teaching concerning a display having a cathode and grid structure like that shown, e.g. in U.S. Patent No. 4,742,345 and having the capacity to selectively erase a single character.

It is therefore an object of the present invention to provide such an electrophoretic display.

The problems and disadvantages associated with the selected erasure of conventional electrophoretic displays are overcome by the present invention which includes an electrophoretic display including a fluid-tight envelope having a portion thereof which is at least partially transparent, an electrophoretic fluid contained within said envelope, said fluid having pigmented particles suspended therein, said electrophoretic display being characterised in that:

means for selectively erasing at least one displayed character with an electrostatic charge without erasing other displayed characters, the erasing means including a first addressable X-Y matrix for selectively establishing a discrete electrostatic charge across at least one intersection of the first X-Y matrix, for erasing said at least one displayed character on said display, the erasing means further including a second addressable X-Y matrix for selectively establishing a discrete electrostatic charge across intersections of the second X-Y matrix for writing pixel data on the display.

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of an electrophoretic display in accordance with an exemplary embodiment of the present invention.

FIG.2 is a cross-sectional view of the electrophoretic display shown in FIG. 1 in the unexploded state, taken along section line II-II and looking in the direction of the arrows.

FIG. 3 is an enlarged perspective view of an anode element of the device depicted in FIGS. 1 and 2.

FIG. 4 is a diagram of a portion of the anode of the display shown in FIGS. 1 and 2 showing an exemplary grouping of anode elements.

FIG. 1 shows an electrophoretic display 10 in accordance with the present invention. The display 10 has an anode faceplate 12 and a cathode faceplate 14 which are sealably affixed on either side of an interstitial wall 16 to form a fluid tight envelope for containing dielectric/pigment particle suspension or electrophoretic fluid (not shown). The faceplates 12 and 14 are typically flat glass plates upon which are deposited conductor elements for controlling the electrostatic charge for inducing motion in the electrophoretic fluid. The techniques, materials and dimensions used to form conductor elements upon the cathode faceplate, i.e., the cathode and grid, are shown in U.S. Patent Nos. 4,655,897, 4,732,830 and 4,742,345.

In the present invention, the conductor members on the anode faceplate 12 are configured very similarly to those of the known cathode faceplate 14. In particular, the horizontal anode elements 18 are produced by etching an Indium-Tin-Oxide (ITO) coated glass plate. The present invention differs from previous constructs, however, in that a layer of Silicon Dioxide SiO_2 is then deposited over the etched ITO glass surface. Following deposition of the SiO_2, the conventional construct is continued, i.e., a layer of insulator is then deposited over the SiO_2 layer and the insulator is coated with a metal. The metal is then etched to produce the vertical anode elements 20. Only a few horizontal 18 and vertical 20 anode members are depicted for ease of illustration. Similarly, the shape and proportions of the elements depicted are for purposes of illustration only. In actual displays there are many more elements, e.g., 640 horizontal members and 1280 vertical members. It is common in the art to refer to conductor members like 18 and 20 as "lines". Conductor members oriented in a first direction, such as the horizontal members 18, are frequently described as extending in the "x-direction". The vertical members 20 could then be said to run in the "y-direction", so that when viewed along a line approximately perpendicular to the planes containing the "x" and "y" lines, the x and y lines form a cartesian coordinate system or an x-y matrix. As is known in the art, an x-y matrix of electrically chargeable lines can, via appropriate circuit drivers connected to the lines, be "addressed", such that at any given intersection in the matrix can be impressed with a desired voltage. This construct has been employed in the cathode-grid matrix described in the above referenced patents issued to the inventors herein. The horizontal and vertical members are grouped, however, as shall be described below. U.S. Patent Nos. 4,742,345 and 4,772,820 may be referred to for more verisimilar illustrations of electrophoretic display elements.

Essentially then, the anode faceplate 12 and the elements 18 and 20, with the exception of the SiO_2 layer, have the same basic form as known cathode/grid faceplates. The horizontal anode elements 18 are etched on ITO coated glass as are the conventional horizontal cathode members. The vertical anode elements 20 are superimposed on the horizontal members and are insulated therefrom by an interstitial photoresist layer as the grid members are insulated from the cathode members. The vertical anode elements are formed by coating the photoresist layer with a metal, such as nickel, using sputtering techniques, or the like, and then masked and etched like the conventional grid elements. Thus, the anode is a matrix of a plurality of elongated, parallel, horizontal members 18 upon which is superimposed a plurality of elongated parallel vertical members 20, a strip of insulator electrically and physically separating the two sets of anode elements.

FIG. 2 shows the electrophoretic display of FIG. 1

assembled in a cross-section. The SiO_2 layer 22 deposited over the horizontal anode elements 18 and the supporting anode faceplate 12 surface is visible in this view. Similarly, the remnants of the etched anode insulation layer, i.e., the anode insulator strips 24 can be seen in FIG. 2. An examination of the upper portion of FIG. 2 reveals the cathode elements 26, grid elements 28 and grid insulator strips 30 as are known in the art. All conductor elements are quite thin and extend beneath the interstitial wall 16 at at least one end thereof to provide a terminal exterior to the envelope for connecting display driver circuitry (not shown).

FIG. 3 illustrates the preferred form of the vertical anode elements. As can be seen, the elements are slotted or tined. It is preferred that 640 horizontal elements be deposited upon the anode screen having an overall width of 112 micrometers, a length approximating the viewing screen width and separated one from the next in the vertical direction by a space of 15 micrometers. Groups of 24 horizontal elements are electrically connected at the ends thus giving approximately 26 horizontal anode element groups corresponding to 25 lines of character text to be displayed and erased an additional border area. It is preferred that 1280 vertical anode elements be deposited upon the anode screen (atop the SiO_2 layer 22 and anode insulator strips 24), each having a slotted configuration as shown in FIG. 3 and an overall width of 112 micrometers, a length approximating the viewing screen height and separated one from the next in the horizontal direction by a space of 15 micrometers. Groups of 16 vertical elements (not just the tines) are connected at the ends thus giving 80 vertical anode element groups corresponding to the 80 columns of character text to be displayed and erased. It is preferred that the slots in the vertical anode elements be extended through the insulation layer (strips) 24 as is taught in U.S. Patent No. 4,742,345.

FIG. 4 diagrammatically depicts the grouping of horizontal 18 and vertical 20 anode elements.

In operation, the anode matrix may be used in conjunction with the cathode and grid to selectively erase single characters at the intersection of particular horizontal 18 and vertical 20 anode element groups, or may be operated as a monolithic anode. For example, in single character erase mode, all horizontal (outer) anode elements 18 may be set positive relative to the cathode, grid and vertical (inner) anode elements 20. When a desired character is to be erased, a selected horizontal element 18 group is made negative relative to intersecting vertical anode elements. Thus, at the intersection, and only at the intersection, is the barrier caused by the vertical element 20 group lowered and a sufficient voltage gradient established to induce pigment particle migration. In a similar manner, writing to a selected character location may be enabled or disabled.

Claims

1. An electrophoretic display (10) including a fluid-tight envelope (12,14,16) having a portion thereof which is at least partially transparent, an electrophoretic fluid contained within said envelope (12,14,16), said fluid having pigmented particles suspended therein, said electrophoretic display (10) being characterised in that:

   means for selectively erasing at least one displayed character with an electrostatic charge without erasing other displayed characters, the erasing means including a first addressable X-Y matrix (18,20) for selectively establishing a discrete electrostatic charge across at least one intersection of the first X-Y matrix (18,20), for erasing said at least one displayed character on said display, the erasing means further including a second addressable X-Y matrix (26,28) for selectively establishing a discrete electrostatic charge across intersections of the second X-Y matrix (26,28) for writing pixel data on the display (10).

2. The display (10) of Claim 1, further characterised in that the first addressable X-Y matrix having a first plurality of conductor members in the X-direction (18) and a first plurality of conductor members in the Y-direction (20).

3. The display (10) of Claim 2, further characterised in that the second addressable X-Y matrix having a second plurality of conductor members in the X-direction (26) and a second plurality of conductor members in the Y-direction (28).

4. The display (10) of Claim 3, further characterised in that the first and second matrices are substantially parallel and the intersections thereof occupy fixed positions relative to each other.

5. The display (10) of Claim 4, further characterised in that the intersections of the first matrix (18,20) and the intersections of the second matrix (26,28) exhibit a fixed relative alignment such that each intersection of the second matrix (26,28) is spatially associated with a corresponding intersection of the first matrix (18,20).

6. The display (10) of Claim 5, further characterised in that the X and Y conductor members of the first and second matrices assume voltage levels such that at the respective intersections thereof display data may be written and erased under the control of an electrostatic field established between the corresponding intersections.

7. The display (10) of Claim 6, further characterised in that each of the intersections of the second matrix

(26,28) serves as the loci for a displayable pixel and the intersections of the first matrix (18,20) have an area at least as small as the area of a displayable character composed of displayable pixels.

8. The display (10) of Claim 3, further characterised in that the envelope includes a first flat faceplate (12), a central portion of which is the transparent portion of the envelope, the first faceplate (12) being a substrate for supporting the first plurality of conductor members in the X-direction (18).

9. The display (10) of Claim 8, further characterised in that the envelope includes a second flat faceplate (14) and a wall member (16), the wall member (16) interposed between and sealably attached to the first and second faceplates (12,14) to form the envelope, the second matrix (26,28) being positioned proximate to the second faceplate (14).

10. The display (10) of Claim 9, further characterised in that the first plurality of conductor members in the X-direction (18) are at least partially insulated from the first plurality of conductor members in the Y-direction (20) by an insulator strip (24) underlying each of the first plurality of conductor members in the Y-direction (20) and parallel thereto.

11. The display (10) of Claim 10, further characterised in that the first plurality of conductor members in the X-direction (18) is further insulated from the first plurality of conductor members in the Y-direction (20) by a layer of semiconductor-oxide material (22) deposited over the first plurality of conductor members in the X-direction (18).

12. The display (10) of Claim 11, further characterised in that each of the first plurality of conductor members in the X-direction (18) and each of the first plurality of conductor members in the Y-direction (20) are slotted and the insulator strips (24) underlying the first plurality of conductor members in the Y-direction (20) are slotted.

13. The display (10) of Claim 12, further characterised in that the first plurality of conductor members in the X-direction (18) are grouped into electrically connected groups, each of the groups having a height approximating the height of a displayable character, and the first plurality of conductor members in the Y-direction (20) are grouped into electrically connected groups, each of the groups having a width approximating the width of a displayable character, such that the area of intersection of a group of first conductor members in the X-direction and a group of first conductor members in the Y-direction approximates the area of a single displayable character.

14. The display (10) of Claim 13, further characterised in that the semiconductor-oxide material (22) is Silicon Dioxide.

15. The display (10) of Claim 14, further characterised in that the second faceplate (14) is a substrate for supporting the second plurality of conductor members in the X-direction (26) and wherein the second plurality of conductor members in the X-direction (26) are at least partially insulated from the second plurality of conductor members in the Y-direction (28) by an insulator strip (30) underlying each of the first plurality of conductor members in the Y-direction (28) and parallel thereto, the first and second plurality of conductor members in the X-direction (18,26) being aligned and the first and second plurality of conductor members in the Y-direction (20,28) being aligned.

16. The display (10) of Claim 15, further characterised in that the display (10) is a triode type, the first matrix (18,20) being the anode, the second plurality of conductor members in the X-direction (26) being the cathode and the second plurality of conductor members in the Y-direction (28) being the grid.

17. The display (10) of Claim 16, further characterised in that the second faceplate (14) is at least partially transparent and the electrophoretic fluid is visible therethrough.

18. The display (10) of Claim 14, further characterised in that the second faceplate (14) is a substrate for supporting the second plurality of conductor members in the Y-direction (28) and wherein the second plurality of conductor members in the X-direction (26) are at least partially insulated from the second plurality of conductor members in the Y-direction (28) by an insulator strip (30) underlying each of the first plurality of conductor members in the X-direction (26) and parallel thereto, the first plurality of conductor members in the X-direction (18) being aligned with the second plurality of conductor members in the Y-direction (28) and the first plurality of conductor members in the Y-direction (20) being aligned with the second plurality of conductor Members in the X-direction (28).

19. The display (10) of Claim 18, further characterised in that the display (10) is a triode type, the first matrix (18,20) being the anode, the second plurality of conductor members in the X-direction (26) being the grid and the second plurality of conductor members in the Y-direction (28) being the cathode.

20. The display (10) of Claim 19, further characterised in that the second faceplate (14) is at least partially transparent and the electrophoretic fluid is visible

therethrough.

21. A method for selectively erasing at least one character from an electrophoretic display (10) comprising the steps of:

imposing a set of voltage levels upon the ordinate and abscissa lines of a first addressable X-Y matrix of conductor members (18,20) contained within the display (10) such that across at least one selected intersection of the first X-Y matrix (18,20) an electrostatic field is created which erases a character displayed on the display (10) proximate to the at least one intersection and wherein the display (10) includes a second addressable X-Y matrix (26,28) of conductor members for writing pixel data at the intersections thereof, the intersections of both the first matrix (18,20) and the second matrix (26,28) having a functional relationship such that when the step of erasing is initiated at an intersection of the first matrix (18,20), a predetermined set of pixels of at least one in number are erased at the second matrix (26,28) if previously in a written state.

22. The method of claim 21, wherein the electrostatic field present at the at least one intersection of the first matrix (18,20) during the step of erasing establishes a voltage gradient between the at least one intersection of the first matrix (18,20) and the intersections of the second matrix (26,28) proximate to the predetermined set of pixels, the gradient causing a migration of pigment particles through the electrophoretic fluid of the display (10) away from a display position and into an erase position.

Patentansprüche

1. Elektrophoretisches Display (10) mit einer flüssigkeitsdichten Hülle (12, 14, 16) mit einem Abschnitt, der mindestens teilweise transparent ist, und einem in besagter Hülle (12, 14, 16) enthaltenen elektrophoretischen Fluid, in welchem pigmentierte Partikel schweben, wobei besagtes elektrophoretisches Display (10) dadurch gekennzeichnet ist, daß:

Mittel zum selektiven Löschen von mindestens einem auf dem Display erscheinenden Zeichen mit einer elektrostatischen Ladung ohne Löschen anderer auf dem Display erscheinender Zeichen vorgesehen sind, wobei die Löschmittel aus einer ersten adressierbaren X-Y-Matrix (18, 20) zur selektiven Erzeugung einer separaten elektrostatischen Ladung über mindestens einen Schnittpunkt der ersten X-Y-Matrix (18, 20) zum Löschen des besagten mindestens einen auf dem Display erscheinenden Zeichens sowie aus einer zweiten adressierbaren X-Y-Matrix (26, 28) zur selektiven Erzeugung einer separaten elektrostatischen Ladung über Schnittpunkte der zweiten X-Y-Matrix (26, 28) zum Schreiben von Bildelementdaten auf dem Display (10) bestehen.

2. Display (10) gemäß Anspruch 1, ferner dadurch gekennzeichnet, daß die erste adressierbare X-Y-Matrix eine erste Vielheit von Leiterelementen in X-Richtung (18) und eine erste Vielheit von Leiterelementen in Y-Richtung (20) aufweist.

3. Display (10) gemäß Anspruch 2, ferner dadurch gekennzeichnet, daß die zweite adressierbare X-Y-Matrix eine zweite Vielheit von Leiterelementen in X-Richtung (26) und eine zweite Vielheit von Leiterelementen in Y-Richtung (28) aufweist.

4. Display (10) gemäß Anspruch 3, ferner dadurch gekennzeichnet, daß die erste und die zweite Matrix im wesentlichen parallel sind und ihre Schnittpunkte im Verhältnis zueinander eine feste Lage einnehmen.

5. Display (10) gemäß Anspruch 4, ferner dadurch gekennzeichnet, daß die Schnittpunkte der ersten Matrix (18, 20) und die Schnittpunkte der zweiten Matrix (26, 28) im Verhältnis zueinander eine feste Ausrichtung aufweisen, so daß ein jeder Schnittpunkt der zweiten Matrix (26, 28) räumlich mit einem entsprechenden Schnittpunkt der ersten Matrix (18, 20) verbunden ist.

6. Display (10) gemäß Anspruch 5, ferner dadurch gekennzeichnet, daß die X- und Y-Leiterelemente der ersten und der zweiten Matrix Spannungswerte annehmen, so daß bei ihren jeweiligen Schnittpunkten unter der Steuerung eines zwischen den entsprechenden Schnittpunkten entstehenden elektrostatischen Feldes Displaydaten geschrieben und gelöscht werden können.

7. Display (10) gemäß Anspruch 6, ferner dadurch gekennzeichnet, daß ein jeder der Schnittpunkte der zweiten Matrix (26, 28) als Ort für ein darstellbares Bildelement fungiert und die Schnittpunkte der ersten Matrix (18, 20) eine Fläche haben, die mindestens so klein ist wie die Fläche eines aus darstellbaren Bildelementen bestehenden darstellbaren Zeichens.

8. Display (10) gemäß Anspruch 3, ferner dadurch gekennzeichnet, daß die Hülle einen ersten flachen Schirmträger (12) aufweist, wovon ein mittlerer Abschnitt den transparenten Teil der Hülle bildet, wobei der erste Schirmträger (12) ein Substrat für die erste Vielheit von Leiterelementen in X-Richtung (18) bildet.

9. Display (10) gemäß Anspruch 8, ferner dadurch gekennzeichnet, daß die Hülle einen zweiten flachen

Schirmträger (14) und ein Wandlelement (16) aufweist, wobei das Wandelement (16) zur Bildung der Hülle zwischen den beiden Schirmträgern (12, 14) angeordnet und abdichtbar daran befestigt ist und die zweite Matrix (26, 28) in der Nähe des zweiten Schirmträgers (14) angeordnet ist.

10. Display (10) gemäß Anspruch 9, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richtung (18) durch einen unter einem jeden der ersten Vielheit von Leiterelementen in Y-Richtung (20) liegenden und parallel dazu verlaufenden Isolationsstreifen (24) zumindestens teilweise gegen die erste Vielheit von Leiterelementen in Y-Richtung (20) isoliert wird.

11. Display (10) gemäß Anspruch 10, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richttung (18) ferner durch eine über der ersten Vielheit von Leiterelementen in X-Richtung (18) abgelagerte Schicht aus Halbleiter-Oxidmaterial (22) gegen die erste Vielheit von Leiterelementen in Y-Richtung (20) isoliert wird.

12. Display (10) gemäß Anspruch 11, ferner dadurch gekennzeichnet, daß ein jedes der ersten Vielheit von Leiterelementen in X-Richtung (18) und ein jedes der ersten Vielheit von Leiterelementen in Y-Richtung (20) geschlitzt ist und daß die unter der ersten Vielheit von Leiterelementen in Y-Richtung (20) liegenden Isolationsstreifen (24) geschlitzt sind.

13. Display (10) gemäß Anspruch 12, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richttung (18) in elektrisch miteinander verbundene Gruppen eingeteilt ist, deren Höhe jeweils ungefähr der Höhe eines darstellbaren Zeichens entspricht, und daß die erste Vielheit von Leiterelementen in Y-Richtung (20) in elektrisch miteinander verbundene Gruppen eingeteilt ist, deren Breite jeweils ungefähr der Breite eines darstellbaren Zeichens entspricht, so daß die Fläche des Schnittpunktes einer Gruppe von ersten Leiterelementen in X-Richtung und einer Gruppe von ersten Leiterelementen in Y-Richtung ungefähr der Fläche eines darstellbaren Einzelzeichens entspricht.

14. Display (10) gemäß Anspruch 13, ferner dadurch gekennzeichnet, daß das Halbleiter-Oxidmaterial (22) Siliziumdioxid ist.

15. Display (10) gemäß Anspruch 14, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) ein Substrat für die zweite Vielheit von Leiterelementen in X-Richtung (26) bildet, wobei die zweite Vielheit von Leiterelementen in X-Richtung (26) durch einen unter unter einem jeden der ersten Vielheit von Leiterelementen in Y-Richtung (28) liegenden und parallel dazu verlaufenden Isolationsstreifen (30) zumindestens teilweise gegen die zweite Vielheit von Leiterelementen in Y-Richtung (28) isoliert wird, und wobei die erste und zweite Vielheit von Leiterelementen in X-Richtung (18, 26) miteinander fluchten und die erste und zweite Vielheit von Leiterelementen in Y-Richtung (20, 28) miteinander fluchten.

16. Display (10) gemäß Anspruch 15, ferner dadurch gekennzeichnet, daß das Display (10) ein Trioden-Display ist, wobei die erste Matrix (18, 20) die Anode, die zweite Vielheit von Leiterelementen in X-Richtung (26) die Kathode und die zweite Vielheit von Leiterelementen in Y-Richtung (28) das Gitter bildet.

17. Display (10) gemäß Anspruch 16, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) mindestens teilweise transparent ist und das elektrophoretische Fluid dadurch zu sehen ist.

18. Display (10) gemäß Anspruch 14, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) ein Substrat für die zweite Vielheit von Leiterelementen in Y-Richtung (28) bildet, wobei die zweite Vielheit von Leiterelementen in X-Richtung (26) durch einen unter unter einem jeden der ersten Vielheit von Leiterelementen in X-Richtung (26) liegenden und parallel dazu verlaufenden Isolationsstreifen (30) zumindestens teilweise gegen die zweite Vielheit von Leiterelementen in Y-Richtung (28) isoliert wird, und wobei die erste Vielheit von Leiterelementen in X-Richtung (18) mit der zweiten Vielheit von Leiterelementen in Y-Richtung (28) und die erste Vielheit von Leiterelementen in Y-Richtung (20) mit der zweiten Vielheit von Leiterelementen in X-Richtung (28) fluchtet.

19. Display (10) gemäß Anspruch 18, ferner dadurch gekennzeichnet, daß das Display (10) ein Trioden-Display ist, wobei die erste Matrix (18, 20) die Anode, die zweite Vielheit von Leiterelementen in X-Richtung (26) das Gitter und die zweite Vielheit von Leiterelementen in Y-Richtung (28) die Kathode bildet.

20. Display (10) gemäß Anspruch 19, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) mindestens teilweise transparent ist und das elektrophoretische Fluid dadurch zu sehen ist.

21. Verfahren zum selektiven Löschen von mindestens einem Zeichen aus einem elektrophoretischen Display (10), bestehend aus den folgenden Schritten:

Anlegen eines Satzes von Spannungswerten an die Ordinaten- und Abszissenlinien einer ersten

adressierbaren X-Y-Matrix aus Leiterelementen (18, 20) im Display (10), so daß über mindestens einem ausgewählten Schnittpunkt der ersten X-Y-Matrix (18, 20) ein elektrostatisches Feld entsteht, das ein auf dem Display (10) neben dem mindestens einen Schnittpunkt erscheinendes Zeichen löscht, wobei das Display (10) eine zweite adressierbare X-Y-Matrix (26, 28) aus Leiterelementen zum Schreiben von Bildelementdaten an ihren Schnittpunkten aufweist und die Schnittpunkte der ersten Matrix (18, 20) und der zweiten Matrix (26, 28) in einem Funktionsverhältnis zueinander stehen, so daß bei Einleitung des Löschschrittes bei einem Schnittpunkt der ersten Matrix (18, 20) ein vorgegebener Satz von mindestens einem Bildelement, falls zuvor geschrieben, bei der zweiten Matrix (26, 28) gelöscht wird.

22. Verfahren gemäß Anspruch 21, wobei das beim Löschschritt bei dem mindestens einen Schnittpunkt der ersten Matrix (18, 20) vorhandene elektrostatische Feld ein Spannungsgefälle zwischen dem mindestens einen Schnittpunkt der ersten Matrix (18, 20) und den Schnittpunkten der zweiten Matrix (26, 28) neben dem vorgegebenen Satz von Bildelementen erzeugt, wobei das Gefälle eine Wanderung der Pigmentpartikel durch das elektrophoretische Fluid des Displays (10) von einer Displayposition zu einer Löschposition veranlaßt.

Revendications

1. Un afficheur électrophorétique (10) comprenant une enveloppe étanche au fluide (12,14,16) ayant une portion qui est au moins partiellement transparente, un fluide électrophorétique contenu dans ladite enveloppe (12,14,16), ledit fluide ayant des particules de pigment qui y sont suspendues, ledit afficheur électrophorétique (10) étant caractérisé en ce que:

   des moyens sont fournis pour effacer sélectivement au moins un caractère affiché avec une charge électrostatique sans effacer les autres caractères affichés, les moyens d'effacement comprenant une première matrice X-Y adressable (18,20) pour établir sélectivement une charge électrostatique discrète sur au moins une intersection de la première matrice X-Y (18,20), pour effacer au moins un caractère affiché sur ledit afficheur, les moyens d'effacement comprenant en outre une seconde matrice X-Y adressable (26,28) pour établir sélectivement une charge électrostatique discrète sur les intersections de la seconde matrice X-Y (26,28) pour écrire les données de pixel sur l'afficheur (10).

2. L'afficheur (10) suivant la Revendication 1, en outre caractérisé en ce que la première matrice X-Y adressable a une première pluralité de membres conducteurs dans la direction X (18) et une première pluralité de membres conducteurs dans la direction Y (20).

3. L'afficheur (10) suivant la Revendication 2, en outre caractérisé en ce que la seconde matrice X-Y adressable a une seconde pluralité de membres conducteurs dans la direction X (26) et une seconde pluralité de membres conducteurs dans la direction Y (28).

4. L'afficheur (10) suivant la Revendication 3, en outre caractérisé en ce que les première et seconde matrices sont substantiellement parallèles et que les intersections de celles-ci occupent des positions fixes les unes par rapport aux autres.

5. L'afficheur (10) suivant la Revendication 4, en outre caractérisé en ce que les intersections de la première matrice (18,20) et les intersections de la seconde matrice (26,28) présentent un alignement relatif fixe de sorte que chaque intersection de la seconde matrice (26,28) est dans l'espace associée à une intersection correspondante de la première matrice (18,20).

6. L'afficheur (10) suivant la Revendication 5, en outre caractérisé en ce que les membres conducteurs X et Y des première et seconde matrices supportent des niveaux de tension tels qu'aux intersections respectives, des données d'affichage peuvent être écrites et effacées sous le contrôle d'un champ électrostatique établi entre les intersections correspondantes.

7. L'afficheur (10) suivant la Revendication 6, en outre caractérisé en ce que chacune des intersections de la seconde matrice (26,28) sert de lieu pour un pixel affichable et les intersections de la première matrice (18,20) ont une surface au moins aussi petite que la surface d'un caractère affichable composé de pixels affichables.

8. L'afficheur (10) suivant la Revendication 3, en outre caractérisé en ce que l'enveloppe comprend une première dalle plate (12), dont une portion centrale est la portion transparente de l'enveloppe, la première dalle (12) étant un substrat pour supporter la première pluralité des membres conducteurs dans la direction X (18).

9. L'afficheur (10) suivant la Revendication 8, en outre caractérisé en ce que l'enveloppe comprend une seconde dalle plate (14) et un membre de paroi (16), le membre de paroi (16) interposé entre et attaché de manière étanche aux première et seconde

dalles (12,14) pour former l'enveloppe, la seconde matrice (26,28) étant placée de manière immédiatement adjacente à la seconde dalle (14).

10. L'afficheur (10) suivant la Revendication 9, en outre caractérisé en ce que la première pluralité de membres conducteurs dans la direction X (18) est au moins partiellement isolée de la première pluralité de membres conducteurs dans la direction Y (20) par une bande d'isolation (24) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction Y (20) et parallèle à ceux-ci.

11. L'afficheur (10) suivant la Revendication 10, en outre caractérisé en ce que la première pluralité de membres conducteurs dans la direction X (18) est en outre isolée de la première pluralité de membres conducteurs dans la direction Y (20) par une couche d'un matériau d'oxyde semi-conducteur (22) déposé sur la première pluralité de membres conducteurs dans la direction X (18).

12. L'afficheur (10) suivant la Revendication 11, en outre caractérisé en ce que chacun des membres de la première pluralité de membres conducteurs dans la direction X (18) et chacun des membres de la première pluralité de membres conducteurs dans la direction Y (20) sont à fentes et les bandes d'isolation (24) sous-jacentes à la première pluralité de membres conducteurs dans la direction Y (20) sont à fentes.

13. L'afficheur (10) suivant la Revendication 12, en outre caractérisé en ce que la première pluralité des membres conducteurs dans la direction X (18) est groupée en groupes électriquement connectés, chacun des groupes ayant une hauteur faisant approximativement la hauteur d'un caractère affichable, et la première pluralité de membres conducteurs dans la direction Y (20) est groupée en groupes électriquement connectés, chacun des groupes ayant une largeur faisant approximativement la largeur d'un caractère affichable, de sorte que la surface d'intersection d'un groupe de premiers membres conducteurs dans la direction X et d'un groupe de premiers membres conducteurs dans la direction Y correspond approximativement à la surface d'un seul caractère affichable.

14. L'afficheur (10) suivant la Revendication 13, en outre caractérisé en ce que le matériau d'oxyde semi-conducteur (22) est du Dioxyde de Silicium.

15. L'afficheur (10) suivant la Revendication 14, en outre caractérisé en ce que la seconde dalle (14) est un substrat pour supporter la seconde pluralité de membres conducteurs dans la direction X (26) et où la seconde pluralité de membres conducteurs dans la direction X (26) est au moins partiellement isolée de la seconde pluralité de membres conducteurs dans la direction Y (28) par une bande d'isolation (30) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction Y (28) et parallèle à ceux-ci, les première et seconde pluralités de membres conducteurs dans la direction X (18,26) étant alignées et les première et seconde pluralités de membres conducteurs dans la direction Y (20,28) étant alignées.

16. L'afficheur (10) suivant la Revendication 15, en outre caractérisé en ce que l'afficheur (10) est un type triode, la première matrice (18,20) étant l'anode, la seconde pluralité de membres conducteurs dans la direction X (26) étant la cathode et la seconde pluralité de membres conducteurs dans la direction Y (28) étant la grille.

17. L'afficheur (10) suivant la Revendication 16, en outre caractérisé en ce que la seconde dalle (14) est au moins partiellement transparente et le fluide électrophorétique peut y être vu au travers.

18. L'afficheur (10) suivant la Revendication 14, en outre caractérisé en ce que la seconde dalle (14) est un substrat pour supporter la seconde pluralité de membres conducteurs dans la direction Y (28) et où la seconde pluralité de membres conducteurs dans la direction X (26) est au moins partiellement isolée de la seconde pluralité de membres conducteurs dans la direction Y (28) par une bande d'isolation (30) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction X (26) et parallèle à ceux-ci, la première pluralité de membres conducteurs dans la direction X (18) étant alignée avec la seconde pluralité de membres conducteurs dans la direction Y (28) et la première pluralité de membres conducteurs dans la direction Y (20) étant alignée avec la seconde pluralité de membres conducteurs dans la direction X (28).

19. L'afficheur (10) suivant la Revendication 18, en outre caractérisé en ce que l'afficheur (10) est un type triode, la première matrice (18,20) étant l'anode, la seconde pluralité de membres conducteurs dans la direction X (26) étant la grille et la seconde pluralité de membres conducteurs dans la direction Y (28) étant la cathode.

20. L'afficheur (10) suivant la Revendication 19, en outre caractérisé en ce que la seconde dalle (14) est au moins partiellement transparente et le fluide électrophorétique peut y être vu au travers.

21. Un procédé pour effacer sélectivement au moins un

caractère d'un afficheur électrophorétique (10) comprenant les étapes de:

application d'un ensemble de niveaux de tension sur les lignes d'ordonnée et d'abscisse d'une première matrice X-Y adressable de membres conducteurs (18,20) contenue dans l'afficheur (10) de sorte qu'en travers au moins une intersection sélectionnée de la première matrice X-Y (18,20) un champ électrostatique est créé qui efface un caractère affiché sur l'afficheur (10) immédiatement adjacent à au moins une intersection où l'afficheur (10) comprend une seconde matrice X-Y adressable (26,28) de membres conducteurs pour écrire des données de pixels aux intersections, les intersections de la première matrice (18,20) et de la seconde matrice (26,28) ayant une relation fonctionnelle de sorte que lorsque l'étape d'effacement est lancée à une intersection de la première matrice (18,20), un ensemble prédéterminé de pixels d'au moins un est effacé au niveau de la seconde matrice (26,28) s'il s'agissait précédemment d'un état écrit.

22. Le procédé suivant la Revendication 21, où le champ électrostatique présent à au moins une intersection de la première matrice (18,20) pendant l'étape d'effacement établit un gradient de tension entre au moins cette intersection de la première matrice (18,20) et les intersections de la seconde matrice (26,28) immédiatement adjacente à l'ensemble prédéterminé de pixels, le gradient entraînant une migration des particules de pigment dans le fluide électrophorétique de l'afficheur (10) d'une position affichage à une position effacement.

FIG-1